THURSDAY, DECEMBER 4, 1879

YALE COLLEGE AND AMERICAN PALÆONTOLOGY

ALTHOUGH notices have from time to time appeared in European scientific journals of the scientific expeditions sent out from Yale College to the Western Territories of the United States, probably only those palæontologists and geologists who have crossed the Atlantic and have had an opportunity of seeing all that is yet visible of the vast amount of material collected at New Haven can adequately realise the enormous additions which have been and are being there daily made to our knowledge of extinct vertebrate life. Thanks to the generous liberality of the late Mr. George Peabody, who has endowed centres of scientific progress in various parts of America, Yale College has been supplied with an admirable Museum of Natural History and with a fund for its maintenance. By his deed of gift the donor provided that after one portion of the money had been employed in erecting the museum, a certain sum ($20,000) should be set apart and invested until it should reach at least five times its original amount, when it might be employed for further building; while the interest of a further sum of $30,000 should be devoted to the maintenance and extension of the collections, in the proportion of three-sevenths to zoology, three-sevenths to geology, and one-seventh to mineralogy.

The wise intentions of the founder have been most faithfully and successfully carried out by his trustees. The building now erected, though forming only one wing of the magnificent pile which they will ultimately complete, is already amply filled with the collections of the several departments. The rooms open to the public are well-lighted, and the cases are carefully arranged and easy of consultation. But by far the larger part of the collections is still stored in the cellars, awaiting the growth of the premises. Unfortunately, however, the boxes are accumulating in these lower regions at a rate which one fears must be greater than that of the building fund.

The mineralogical cabinet has been entirely rearranged and displayed by Mr. E. S. Dana, who, with Prof. Brush, is amply sustaining the old mineralogical renown of New Haven.

The unique feature, however, in the Peabody Museum, is the vast collection of vertebrate fossils from the Western Territories, made by the enthusiastic labours of Prof. O. C. Marsh. Only a small portion of this enormous series has yet been placed in cases for public inspection. But the Professor, with infinite courtesy and patience, conducted the writer of these lines through the stores from cellar to roof, brought under his notice examples of the more interesting and important of the "finds," and furnished him with notes of the collection and permission to use them, of which he now gladly avails himself.

After having spent several years in bringing together, from the Cretaceous and Tertiary strata of the Atlantic coast, a very considerable mass of material, the Professor came to the conclusion that this field was essentially exhausted, and that it was to the unexplored territory beyond the Missouri River, that the palæontologist must now look for additional facts to help him to an intelligent comprehension of the progress of vertebrate life in the past. This conclusion having been confirmed by his own observations during a short trip to the Rocky Mountains in 1868, he, in 1870, organised the first of the Yale Scientific Expeditions. After spending five months in the field the party returned well laden with fossil treasures from the Cretaceous and Tertiary formations. The success of this experiment having been so marked the four succeeding years witnessed the departure of as many expeditions, all of which were likewise successful. The results may be briefly summed up in the statement that, altogether, within six years, these expeditions under Prof. Marsh brought to light more than four hundred species of vertebrate fossils new to science, of which only about two-thirds have as yet been described. At the time when these explorations began, the West was almost wholly unknown, and the investigators were exposed to great hardships and to no little danger from hostile Indians. It is to be hoped that Prof. Marsh may be induced to write down and publish a narrative of his life and adventures in the wild west in search of fossils. The samples which in friendly talk he communicated to the present writer were so entertaining, that the book could not fail to prove most interesting, and would no doubt help on the cause of palæontology in America.

Among the numerous extinct animals discovered during the progress of these explorations are many groups which differ widely from any forms of life previously known. Prominent among these, and extremely interesting from their bearing on questions of evolution, are the toothed birds of the Cretaceous formation, the *Odontornithes*, all the known specimens of which are in the Yale Museum. These constitute a new sub-class, and have been divided into two well-marked orders: the *Odontolcæ*, which have the teeth implanted in grooves, and the *Odontolormæ*, with the teeth in distinct sockets. The *Odontolcæ* were large swimming birds, somewhat resembling the Divers of the present day, but with rudimentary wings, of no possible use to their possessor. The vertebræ were as in modern birds. The typical genus is *Hesperornis*, and at least three species are known. The second order includes small birds, very different in appearance and characters from the preceding group, with large and powerful wings, and biconcave vertebræ. Two genera and several species are known, which belong to this order. The type genus is *Ichthyornis*. All the toothed birds known at present come from the upper Cretaceous of Kansas, and more than one hundred individuals are represented in the Museum. A memoir on this group, with forty quarto plates, by Prof. Marsh, is now in the press.

In the same formation this active explorer discovered the first American Pterodactyls, or flying reptiles. These animals are extremely interesting, not only on account of their enormous size—for some of them have a spread of wings of nearly twenty-five feet—but more especially from the fact that they were destitute of teeth; in this respect resembling modern birds. They represent a new order, *Pteranodontia*, named from the type genus, *Pteranodon*, of which several species are now known. Numerous anatomical points of much importance will, no doubt, be brought to light by a close study of this remarkable

aberrant group, and the ample material now in the museum, representing more than six hundred individuals, will render their elucidation comparatively easy.

With the toothed birds and the Pterodactyls, have been found great numbers of Mosasauroids, a group of reptiles, which, during Cretaceous times, attained an enormous development both as to numbers and the variety of forms by which it was represented. Several new families, including a number of new genera and many species, here appeared, and flourished abundantly. The *Tylosauridæ* were very large, some of them being more than sixty feet in length, while the *Edestosauridæ* were much smaller. The very abundant material secured, representing not less than twelve hundred individuals belonging to this order, has enabled Prof. Marsh to settle many doubtful points with regard to the structure of these reptiles, and to determine that they possessed hind paddles, and were covered with dermal scutes.

The Cretaceous formations of the West likewise have yielded numerous turtles and other reptiles, and many fishes, some of them of great interest, and very full series of specimens of all of these, representing not less than five thousand individuals, are at present in the Yale College Museum. The fame of these discoveries has led other explorers into the same field. A most formidable rival in enthusiasm and energy is Prof. E. D. Cope, who has filled the houses at Philadelphia with bones from the West, who has published some valuable memoirs upon them, and to whose work attention will be directed on another occasion.

Besides the discoveries made by Prof. Marsh and his parties in the Cretaceous of the West, the old Eocene lake-basins between the Rocky Mountains and the Wahsatch Range were, during the summer of 1870, explored with most interesting results, their age being then fully determined and announced. Many remarkable forms of life, most of them very different from anything previously known, have been disinterred. Of all of these, perhaps none are more extraordinary than the gigantic *Dinocerata*, a new order recently established by Prof. Marsh. These animals nearly equalled the elephant in size, but with shorter limbs. The skull was furnished with two or more pairs of horn cores, and with enormous canine tusks similar to those of the walrus, while the brain was proportionally smaller than in any other land mammal. Three genera and several species are known. These great creatures seem to have lived in considerable numbers about the borders of the old Eocene lakes, and their remains are found quite abundantly, buried in the dirt that once formed the muddy bottom. Remains of more than two hundred different individuals are now in the Peabody Museum, and a volume descriptive of them by their discoverer is now in course of preparation.

Another new order of mammals, made known by the same untiring anatomist from these same deposits, is that of the *Tillodontia*. These animals are in many respects very remarkable, and notably in presenting characters which seem to indicate affinities with several widely different groups. Thus the skull, feet, and vertebræ resemble those of some carnivores; the anterior incisors forcibly remind one of the corresponding teeth in the rodents; the lower molars are of the Paleotherium ungulate type. Two families of this order are known: the *Tillotheridæ*, in which only the incisors, and the *Stylinodontidæ*, in which all the teeth grow from persistent pulps. The largest specimens of this order were about the size of a tapir.

From these Eocene deposits, too, were obtained the first remains of fossil *Quadrumana* known from the New World. These early primates, according to their discoverer, seem to have relationships both with the lemurs of the Old World, and with the South American monkeys. Two families have been discovered: the *Lemuravidæ*, named from the principal genus, *Lemuravus*, which have forty-four teeth, and the *Limnotheridæ*, which have not more than forty. The large number of genera and species by which this group is represented in these Eocene deposits, show that, even at this early period, the American primates had reached a high degree of development, and enjoyed, up to that time at least, very favourable conditions for their existence. They are all, however, low generalised forms, the characters of their teeth and other portions of the skeleton bearing considerable resemblance to the corresponding parts in the ungulates and carnivores. Besides the groups already mentioned, the same Eocene lake-basins yielded the remains of marsupials and bats (neither of which had before been found fossil in America), together with many species of birds, serpents, lizards, and fishes.

Since the original account of American fossil horses given by Leidy, the Eocene strata of New Mexico and Wyoming have yielded two very important ungulates, which have helped to complete the history of the descent of the horse, so well worked out by Prof. Marsh. These relics carry back the ancestry of this familiar quadruped to the oldest Tertiary time. The earliest form, *Eohippus*, was about the size of a fox, had forty-four teeth, the molars having short crowns, and being quite different in form from the premolars. There were four well-developed toes, a rudiment of another on the forefoot, and three toes behind. The structure of the feet and of the teeth in *Eohippus* indicates, beyond question, that the direct ancestral line to the modern horse had already separated from the Perissodactyls. The second of these ungulates, *Orohippus*, is from the Wyoming Eocene, and is evidently next to *Eohippus*, which it now replaces in the line of descent. In size it about equalled its predecessor, but the rudimentary digit of the forefoot has disappeared, and the last premolar has gone over to the molar series. Another Eocene equine, discovered in Utah, is *Epihippus*.

The discoveries made by the Yale expeditions in the "Miocene" and Pliocene formations of the Rocky Mountains and the Pacific coast were scarcely less numerous and interesting. From these deposits were obtained the large series of specimens which served to complete the genealogical line of the horse from the four-footed Orohippus of the Eocene to the large *Equus fraternus* of the later Pliocene, which does not differ, appreciably, from the horse of to-day. From the "Lower Miocene" comes *Mesohippus*, which is about the size of a sheep, and has three usable toes of nearly equal size, and a long splint or rudiment of another, corresponding to the second digit of a five-toed foot. *Miohippus*, a somewhat later form, bears a close resemblance to *Mesohippus*, but the side toes are smaller, and the splint is very short. In *Protohippus*,

from the lower Pliocene, there is a considerable increase in size, the splint has disappeared, and the two side toes have become so small that they no longer reach the ground, but are merely dew claws, like those of the deer or ox. *Pliohippus*, which is found in a still higher horizon of the Pliocene, is as large as a donkey, has lost the dew claws, but has the splints much longer than the same bones in the modern equines. Finally, at the top of the Pliocene comes a true *Equus*, which completes the line. Besides the forms mentioned, there are many intermediate ones, which show that the transition has taken place in the order indicated. Many additional characters of the skull, brain, and teeth, add weight to, and confirm, the evidence furnished by the feet.

Among the other treasures of the Museum are bones of mammals allied to the modern rhinoceros, which occur abundantly in strata, said to be of Miocene age, both in Oregon and the Rocky Mountain region. These remains furnish material for tracing the descent of these creatures from the upper Eocene to the close of the Pliocene, when they appear to have become extinct. A strange group of ungulates, found in the so-called Lower Miocene of the plains, were the huge *Brontotheridæ*, which appear to have been allied to the *Dinocerata*, and also to *Rhinoceros*. In size they equalled the *Dinocerata*, and, like them, had an elevated pair of horn cores on the maxillary bones. An immense quantity of the remains of these animals, representing several genera and over two hundred individuals, has been collected, and is now in the Museum.

Until within a year or two, no Tertiary edentates were known from America, although their remains were found in abundance in the superficial post-Tertiary deposits. Recently, however, the Museum has received, from the "Lower Miocene" of Oregon, the remains of two species belonging to this group and to the genus *Moropus*. These are of large size, and were, essentially, huge sloths. From the Pliocene deposits of Idaho and California, and from the same formations east of the Rocky Mountains, other large species have been discovered belonging to the genera *Moropus* and *Morotherium*. Many other groups of mammals, including primates, carnivores, suillines, camels, &c., have been collected in these formations, which also yield numerous birds, reptiles, and fishes.

Although observations had been made by previous investigators, on the size of the brain in Tertiary mammals, Prof. Marsh was the first to institute any systematic inquiry into the laws which governed and the causes which acted upon, brain-growth in these ancient animals. Some of his conclusions, based on specimens now in the Museum, have been already given to the world, but they may be fittingly cited here: (1) All Tertiary Mammals had small brains; (2) there was a gradual increase in the size of the brain during Tertiary time; (3) this increase was mainly confined to the cerebral hemispheres, or higher portion of the brain; (4) in some groups the convolutions of the brain have gradually become more complicated; (5) in some the cerebellum and olfactory lobes have even diminished in size.

Some of the additional conclusions already reached in regard to American Tertiary mammals, so far as they are now known, are stated as follows:—(1) All the *Ungulata* from Eocene and Miocene deposits had upper and lower incisors; (2) all Eocene and Miocene mammals had separate scaphoid and lunar bones; (3) all mammals from these formations had separate metapodial bones.

Although the Cretaceous and Tertiary fossils make up a large part of the geological collections of the Peabody Museum, the other formations are well represented in its store-rooms. This is especially true of the recently discovered Jurassic beds of the Rocky Mountains, which have yielded, since the summer of 1877, a great number of interesting forms. The parties that have been collecting for Prof. Marsh have been more than usually successful, and a study of the strange animals, many of them new to science, which have been sent to the Museum, has resulted in several discoveries of great interest. These Jurassic fossils are chiefly dinosaurs, crocodiles, turtles, and fishes. The first of these are extremely abundant, and the horizon from which they come has been named by Prof. Marsh, from one of the genera there discovered, the Atlantosaurus Beds. These dinosaurs varied widely in size and structure, for while some of them, *e.g.*, *Nanosaurus*, were no larger than a cat, others were, by far, the largest land animals of which we have any knowledge. Among the discovered remains of *Atlantosaurus immanis* is a femur over six feet in length. A comparison of this specimen with the same bone in living reptiles indicates that *Atlantosaurus*, if similar in proportions to the crocodiles, would have been more than one hundred feet in length. The anatomical points cleared up by the discovery of the bones of the feet in these dinosaurs are of great importance and interest. From these same Atlantosaurus Beds come the strange *Stegosauria*, recently described by Prof. Marsh; a new order of reptiles whose affinities are, as yet, but imperfectly understood, but which appear to have most relationship with the dinosaurs. The Atlantosaurus Beds have furnished, moreover, the only Jurassic mammals yet found in America. These remains, apparently all marsupial, belong, so far as known, to four genera and eight species, which Prof. Marsh has described. He has also recently made known, from the marine Jurassic beds of the Rocky Mountains, a peculiar group of reptiles (*Sauranodontidæ*) allied to *Ichthyosaurus*, but without teeth.

An enumeration of the fossil treasures of New Haven would, however, fail to do justice to this marvellous collection if it made no mention of the almost incredible state of preservation of the fossils. A European student is lucky if he finds a tooth or a jaw; most fortunate should he stumble upon a cranium; the envy of the whole tribe of collectors should he disinter a whole skeleton. But even when most successful he meets with the bones often in a fragmentary, or badly preserved condition, or imbedded in so tough a matrix that they cannot be adequately cleared for study without almost certain detriment. The vast regions open to American research in the West, however, are the very paradise of palæontologists. Almost as fresh as if the animals had only recently died, the bones protrude sometimes in great numbers from the edges of the escarpments. When the first explorers went into these tracts they found the skulls grinning at them from the faces of the bare dry verdureless cliffs of the "bad lands." The diligence of Professors Marsh, Cope, and their parties has no doubt cleared away a good many of the prominent objects. But the number still to be exhumed must be enormous.

Entire skeletons with almost every bone in place show how tranquilly and thoroughly the remains of the early Tertiary vertebrates were entombed in the mud of the lakes on whose shores and waters they lived.

A. G.

CHRONOLOGICAL HISTORY OF PLANTS

Chronological History of Plants: Man's Record of his own Existence illustrated through their Names, Uses, and Companionship. By Charles Pickering, M.D. (Boston: Little, Brown, and Co.; London: Trübner and Co., 1879.)

THIS is an extraordinary book, difficult alike to characterise and to review. It is a monument of enormous labour and erudition, but it is not easy to discover the plan upon which it is compiled, and it certainly does not fulfil the promise of its title. A "chronological history of plants" would be an interesting and valuable work, if understood to mean a history of the ages and countries in which particular plants have been introduced from abroad, or those of home growth first adapted to the use of man. This, indeed, is the work which Dr. Pickering seems to have contemplated; it is not, however, the work which he has accomplished.

Neither the historian, the philologist, nor the botanist will be satisfied with the huge volume now presented to them. Dates are given with a show of minute accuracy which the materials for ascertaining them unfortunately do not justify. Thus, to go no further than the second page, we find the mysterious paragraph, "Second generation, September 1st, 4234, among living men." As similar entries occur on the following page, with the names of Enoch, Irad, and other descendants of Cain attached to them, I suppose the paragraph must be interpreted to mean that the second generation of living men first saw light on the 1st of September, B.C. 4234. How Dr. Pickering knew this I cannot imagine. If we turn over a few leaves we find the dates of the early Egyptian kings set down with equal minuteness, and, it must be added, with an equally small show of reason. Dr. Pickering even knows the exact dates of the antediluvian monarchs of Babylonia, though he has forgotten the right name of the town of Pantibibla, from which several of them were said to have come. His knowledge of the heroic age of Greece is equally precise. Thus he tells us that in 1290 B.C. Jasus was "succeeded by Crotopus, son of Agenor, and now ninth King of Argos;" and then follows some interesting information about the Pelasgians and their wanderings.

Dr. Pickering's philology is not less remarkable than his chronology. He shocks the Hebrew scholar by calling *tzôn* ("sheep") *tzan*, of which, by the way, he says that it was "regarded even by Dicæarchus as probably the first animal domesticated"—a statement likely to be disputed by those who have occupied themselves with the history of the domestication of animals. Under the year 1720 B.C., he remarks that "the northern language from which certain Greek words were taken probably at this time in existence"—a statement which will be new to most philologists and Greek scholars. Naturally he has never heard of the explanation of the word *foxglove*, which makes it a popular corruption of *folk's-gleed*, or "row of bells."

But it is the botanist who has most reason to complain of Dr. Pickering's work. Instead of a "chronological history of plants," he finds the names and notices of various specimens of the vegetable world catalogued in the most arbitrary way under dates which have little or no connection with the age in which they were first known or used by man. So far as the earlier half of the book is concerned, the notices might in most instances have been as well entered on another page as that on which they are actually found. Why, for instance, should the *Artemisia absinthium* or the *Iris sambucina* be described under the date 1734 B.C., and what possible connection can there be between 1203 B.C. and the *Phragmites communis*? The only relation that can generally be traced between the dates and the plants recorded under them is little better than a pun. Because the almond or *luz*, which Dr. Pickering calls *lwz*, is mentioned in Genesis xxx. 37, it is recorded under the year 1506 B.C., the year in which Joseph was "born to Jacob and Rachel;" because a brick from the small pyramid of Dashur was discovered to contain the straw of the jointed charlock and field-pea, an account of these plants is given under the year 2079 B.C., the assumed date of the building of the pyramid; and the mention of "Pelasgus establishing himself as king in Arcadia" in 1354 B.C. calls up a description of the *Quercus esculus*. As a set-off against this learned trifling, a vast quantity of matter is introduced which has nothing to do with plants and their history. Thus it would be quite intelligible if the author had given a list of those Egyptian hieroglyphics which represent plants, but the long, though imperfect, catalogue of hieroglyphic characters of all kinds which he actually has given, though fitted for a treatise on Egyptian grammar, is certainly out of place in a history of the vegetable world.

There is only one explanation that can be offered for the character of this extraordinary volume. Dr. Pickering was an able and learned scholar, trained in scientific methods and capable, as is proved by his "Races of Man," of producing good scientific work. But his "Chronological History of Plants" has been published since his death, and has consequently not had the benefit of his own compilation and revision. It consists simply of the notes he collected during a long course of voluminous reading, arranged, not upon any scientific plan, but under the convenient headings of his common-place book. The student may possibly construct a chronological history of plants out of them, but such a history does not exist at present. The volume is a mine of materials which, thanks to a careful index, can be easily used, though considerable caution is required in doing so. As it stands, however, it is hardly better than a mass of undigested and ill-arranged facts, mixed up with dates and statements calculated to send a shudder through the sensitive frame of the critical historian. Posthumous works are not unfrequently the most cruel injury that can be inflicted by friends upon the memory of the dead, and it is hardly likely that Dr. Pickering would have relished the appearance of his elaborate notes in precisely their present form.

A. H. SAYCE

CHALLIS'S "PRACTICAL ASTRONOMY"

Lectures on Practical Astronomy and Astronomical Instruments. By the Rev. James Challis, M.A., F.R.S., &c. (Cambridge: Deighton, Bell, and Co.; London: George Bell and Sons, 1879.)

AS LONG since as the year 1843 the Plumian Professor of Astronomy and Experimental Philosophy in the University of Cambridge commenced a course of lectures upon practical astronomy and the use of astronomical instruments, the proximity of an observatory provided with instruments of first-rate quality appearing to him to give facilities for acquiring a knowledge of the practical branch of the science which ought to be taken advantage of. The syllabus of these lectures has been utilised as the groundwork of the present volume, but the progress of astronomy has necessitated the introduction of various modifications in the original plan and contents.

By far the larger portion of the volume is devoted to the description and use of instruments found in the larger fixed observatories, the illustrations being usually applicable to instruments in the Cambridge Observatory, and the work being therefore more especially adapted to the use of students in that university, who have frequent access to the observatory. Notwithstanding this circumstance, however, the treatise will be found to convey much information on practical matters and details, which is not of so limited an application.

The fixed instruments which are treated of at length are the transit instrument, the mural-circle, the transit-circle, incorporating in its employment the purposes of the two former instruments and the equatorial. The transit-circle may now be said to have wholly superseded the mural-circle and transit-instrument in most of the principal observatories, but the explanations of them given by Prof. Challis being applicable to the reduction of meridional observations generally, are also applicable in great measure to the transit-circle. The latest observations with a mural-circle which we remember to have seen were made at the Naval Observatory, Washington, and the instrument still figures in the last description of that establishment. Prof. Challis enters fully into such details as the mechanical adjustments of a transit instrument and the correction of errors by calculation, the construction and application of the collimating eye-piece, the azimuth-error obtained by astronomical observations, and correction for error of level, also upon a method of correcting the errors of a transit-instrument for deviation of the pivots from a cylindrical form, a defect which, if we are not mistaken, considerably exercised not only Prof. Challis, but his successor Prof. Adams, as exemplified in the Cambridge instrument. The computation of apparent and mean right ascensions follows, with reference to recent corrections of the more important astronomical constants entering into such work. Similarly the author describes the method of observing with the mural-circle, and the calculation of the mean polar distances of stars and the geocentric polar distances of the sun, moon, and planets with numerical examples. The equatorials of the Cambridge Observatory and their appliances are particularly described, and the adjustments of this form of astronomical instrument and the method of deducing the right ascension and polar distance of a celestial object from the observations. Reference is also made to the "counterpoise mounting" of an equatorial, and the arrangements, advantages, and disadvantages of this form of mounting.

Other fixed instruments of which some account is given are the altitude and azimuth instrument, with special reference to that at the Royal Observatory, Greenwich, the zenith sector, Airy's reflex zenith tube, and the transit in the prime vertical. There are also articles upon transportable instruments, as the theodolite and sextant, on the chronographical method of registering transit-observations, the different methods of determining terrestrial longitudes, the solar parallax, and miscellaneous additional subjects of less importance.

The volume, as we have already stated, and, indeed, as is hinted by Prof. Challis, may appear to be more especially adapted to students in the university who desire an acquaintance with the principles of astronomical practice, and in his preface the author urges the advantages of giving attention to a subject of this kind, "as a mental exercise of much educational value, inasmuch as it is altogether unlike any process of reasoning by abstract symbols, and may serve as a corrective to the effect of too exclusive an attention to reasoning of that kind." But there are few works of its nature in English astronomical literature, a circumstance which is likely to secure for it a wider circle of readers.

The volume has been published at the expense of the Syndics of the University Press.

OUR BOOK SHELF

The Carboniferous Limestone and Cefn-y-Fedw Sandstone of the Country between Llanymynech and Minera, North Wales. By George H. Morton, F.G.S., F.R.G.S.I., Honorary Secretary of the Liverpool Geological Society. (London: David Bogue, 1879.)

IN this excellent monograph, which is now reprinted from the *Proceedings* of the Geological Society of Liverpool, Mr. Morton has brought together a vast amount of valuable information concerning the lower carboniferous rocks, as displayed in a district where they have been but little studied. The splendid escarpment of the Eglwyseg rocks, near Llangollen affords a series of magnificent sections, the interpretation of which, however, requires considerable patience, care, and caution on the part of the field geologist. Mr. Morton shows that the succession of the lower carboniferous rocks in North Wales presents marked points of difference from that which is observed either in Yorkshire or Derbyshire. He divides these lower carboniferous rocks into two groups—the carboniferous limestone below and the Cefn-y-Fedw sandstone above; and in the correlation of these he adopts the views originally put forward by Prof. A. H. Green, and since supported by Mr. D. C. Davies, namely, that the conglomerate and sandstone strata overlying the carboniferous limestone represent not only the millstone grit, but also the Yoredale rocks of Prof. Phillips and the Geological Survey.

Mr. Morton shows that the carboniferous limestone of this district attains a thickness of 1,200 feet, and he gives detailed descriptions of the several members of which it is made up, with lists of the fossils obtained from each. The overlying arenaceous formation is 723 feet thick, and consists of alternations of sandstone conglomerate and shale; these beds contain marine shells, with some plant-remains. The sections which are given in this

monograph enable us to trace the numerous and rapid changes which these carboniferous strata undergo within comparatively limited areas. The manner in which the several members of the series overlap one another, as has already been pointed out by Mr. Davies, is also admirably illustrated in this work of Mr. Morton's.

Perhaps no part of this excellent memoir will prove of more general interest to geologists than Mr. Morton's account of the numerous faults which traverse the district; the positions and effects of these being illustrated by a map and several sections. The isolated patch of carboniferous rocks faulted down among the Silurian strata near Corwen is also more fully described than by any previous author. Besides the numerous woodcuts and lithographic plates, the work is illustrated by three admirable photographs by Mr. W. H. Wilson. We heartily recommend this exhaustive monograph to the attention of our readers, as a model of the kind of work which may be advantageously undertaken by the members of local scientific associations. J. W. J.

Magnetism. The High School Series. (London: T. Murby, 1879.)

THE anonymous author of this little work of sixty-eight pages has produced a very readable and in many ways admirable primer of Magnetism for boys and girls. Clearly written, well illustrated, and dealing with such matters of experiment as boys and girls can verify for themselves, it will be sure to command popularity. The experiment on p. 22, which suggests the form of the curve of magnetic intensity along a bar-magnet by the length of the chain of nails which can be hung on at equidistant points, thus building up visible ordinates on the abscissæ is new to us, and as neat as novel. One cannot help wondering, however, why the author has assumed that "high-school" pupils must have mathematics and even arithmetic kept almost entirely out of sight. Why the separate chapters are entitled as "Lectures" is not very evident. The "Lecture," for example, on "Diamagnetism"—the ninth of the ten—is just thirty-seven lines long, and takes just two minutes to read aloud!

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

To Astronomers

I HAVE the honour to inclose to you a copy of a circular which I have lately sent out from my observatory to upwards of 200 observatories, public and private, scattered over the face of the globe. I have long felt that it was highly desirable that some means should be found whereby the discoveries in astronomy should be made public in a rapid and systematic manner, more especially in this country, where I am proud to say we number so many among all classes who take an intelligent and earnest interest in this the highest of the studies of nature. After much thought as to the best means of carrying out the plan, I determined, it may be presumptuously, to endeavour to do the work myself, and to that end I issued the circular to all directors of observatories whose addresses I could lay my hands upon. Should I have the fortune to receive favourable replies from abroad, I hope to make the matter successful. Now as to the distribution of the news in the British Islands: I am making a list of those who apply to me for the circulars and I will endeavour to post these within 24 hours of receiving the notice myself. I have made arrangements with the telegraph officials, that any telegram addressed (as below) shall be sent out at whatever hour it may arrive: I have further set up a small printing press in my observatory from which to pull the circulars, as I feel sure that this is the most convenient method and the least liable to error.

In conclusion I may add that should any devise a better means for doing this work, I will at once place my experience at their disposal and do all I can to assist them. LINDSAY

Haigh Hall, Wigan,
November 29

"The Observatory, Dun Echt, Aberdeen,
"November 1, 1879.

"SIR,—I am very anxious to form some system whereby information of astronomical interest may be rapidly and widely disseminated among English observers; and I would beg to ask for your assistance in carrying out my plan.

"In the event of your discovering a comet, new star, or other object of immediate interest, I would ask you to send me a telegram announcing the discovery and giving such details as are usual.

"I have purposely omitted to mention minor planet discoveries, inasmuch as this branch is already admirably carried out by the Berlin Observatory.

"For convenience, the telegram should be in the form recommended by the Vienna Academy in the 75th vol. of the *Astr. Nachr.*, No. 1785, page 142, as follows:—'Comet (new star, &c.,) Discoverer, Date, Local Mean Time of Observation (in hours and minutes), Place of Discovery, Right Ascension *in Arc* (degrees and minutes), North Polar Distance (degrees and minutes), Daily Motion in R.A. and N.P.D. (minutes of arc) plus or minus, Description, Diameter of Comet, &c. (in minutes of arc).

"Thus a telegram would run:—

"'Comet Winnecke 5 April. 1445 Strassburg 33157 07508 Motion 0 minus 60.'

"This would read:—

"'Comet discovered by Winnecke, 5th of April, 14 hours 45 minutes Mean Time Strassburg, R.A. 331° 57', N.P.D. 75° 8'. Daily Motion, stationary R.A., minus 60' in Polar Distance.'

"Noughts should be put in where are no significant figures, so as to make three figures for degrees, and two for minutes (five in all), in R.A. and in N.P.D., similarly four in the Local Time.

"Telegrams, &c., should be addressed—

"'*Observatory, Dun Echt, Aberdeen.*'

"I will engage to distribute the notices of discovery within 24 hours of receiving the telegram, by means of a circular, sent out by first post from my Observatory, to all those who would be likely to make useful observations, and who will also favour me with their addresses.

"At present, it is only by accident that private observers hear of the discovery of Comets, &c., and it is obviously greatly to the advantage of astronomy that early and reliable information should be spread over the British Islands, without having to wait for its publication in some of our scientific journals.

"I should feel much gratified if I may feel assured of your valuable co-operation in this matter.

"Believe me, yours very faithfully,
"LINDSAY,
"Pres. Roy. Ast. Soc."

The Cresswell Cave Exploration, 1876

IT seems to me proper to notice the statements made by Mr. Heath in a pamphlet on the bone-caves of the Cresswell Crags, published in August last, and since more broadly put in the Manchester press, calling in question the results of the exploration carried on by the Committee in 1876.[1]

It is insinuated that the engraved bone now in the British Museum, discovered by the Rev. J. M. Mello, and the tooth of Machairodus, discovered by myself, are not *bonâ fide* discoveries in the caves of the Cresswell Crags, but were placed there by some one, not specified, and were derived from some other locality, which also is not specified. With regard to the engraved bone, it is only necessary to say that Mr. Heath was not in the Robin Hood Cave when Mr. Mello's discovery was made, while

[1] Committee:—President: Sir John Lubbock, Bart., F.R.S., M.P. Secretary: Prof. Boyd Dawkins, M.A., F.R.S. Treasurer: Fredk. Longden, Esq. Members: Prof. Busk, F.R.S.; Prof. Prestwich, F.R.S.; John Evans, Esq., F.R.S.; A. W. Franks, Esq., F.R.S.; the Rev. J. Magens Mello, M.A., F.G.S.; Rooke Pennington, Esq., LL.B., F.G.S.; William Bragge, Esq., F.G.S.; R. D. Darbishire, Esq., B.A., F.G.S. The work is under the direction of the Rev. J. M. Mello, Prof. Boyd Dawkins and Mr. Heath, F.R.H.S., being superintendents. The Report will be prepared for the Geological Society of London by the Rev. J. M. Mello and Prof. Boyd Dawkins.

it so happens that I was present, and can testify to the accuracy of Mr. Mello's statement. With regard to the tooth of Machairodus, which I discovered and afterwards showed to Mr. Heath, it is asserted that it was without adherent matrix, and without the moisture which it would possess had it been imbedded in the cave for ages. These assertions are disproved by the facts that the tooth unfortunately split in pieces in process of drying, and that the matrix of red earth, only partially removed when it was repaired and gelatinised in the Owens College Museum, is still to be seen in the pulp cavity.

In the exploration of the caves, in 1876, the discoverer, Mr. Mello, was director, while I undertook to name and classify the remains, and we drew up a report published in the *Quart. Geol. Soc. Journ.*, 1877, p. 475. Mr. Heath and myself acted as superintendents of the work, under the direction of Mr. Mello.

It was Mr. Heath's duty as superintendent to hand over to the director the notes on which the above assertions are based, as well as any other notes relating to the work entrusted to him. He did not do so. If he had any fault to find, it was his duty to lay it before the committee, and in the interest of truth to make his statement when the report was read at the meeting of the Geological Society, at which he was present. He did neither of these things. Nor when he had many opportunities of saying what he liked at the meeting of the British Association at Sheffield, after my paper before the Geological Section, and our addresses at Cresswell, did he say one word, although he was present at both. The pamphlet in question was to us the first intimation that he differed with us as to the facts.

In conclusion it only remains for me to add that Mr. Heath was *not* a member of the Exploration Committee, that he was merely a subordinate to Mr. Mello, and that, on his own showing, he kept back for nearly three years notes considered by him to be valuable, which he was in honour bound to communicate at once to the director for the information of the committee—notes which were as much the property of the committee as the fossil remains discovered in the caves at their expense. I am instructed that the only notes which he gave to the director were certain measurements of the inside of the Robin Hood Cave, which it was found necessary to have done over again.

W. Boyd Dawkins,
Secretary of the Cresswell Caves Exploration Committee, 1876

"The Society for the Encouragement of Literature and Science"

The attention of the Council of the Geological Society has been called to the prospectus of a "Society for the Encouragement of Literature and Science," in which the letters "F.G.S." are appended to the name of one of the vice-presidents and to that of the "Secretary-in-Chief." I have been directed by the Council to make it generally known that neither of these gentlemen is a Fellow of the Geological Society, as would naturally be inferred from their use of these letters, and I shall feel greatly obliged by your insertion of this note in your columns.

Geological Society, Burlington House, November 27 — W. S. Dallas, Assist. Sec. Geol. Soc.

The attention of the Council of the Linnean Society of London has been called to a paper or prospectus of a "Society for the Encouragement of Literature and Science," whereof W. Sarjeant-Rodway is stated to be "Secretary-in-Chief," and wherein the names Lewis Biden, A. Ware, and Joseph Blackburn Leslie each appear followed by the letters F.L.S., which letters are those appointed to indicate "Fellow of the Linnean Society"—a chartered society. Its attention has also been called to another paper apparently put forth by a "Conchological Society of London," wherein the name W. Serjeant-Rodway appears as "Secretary and Founder," with the addition of the letters F.L.S. (Lond.).

As no one of these four gentlemen is a Fellow of the Linnean Society, the Council of the same Society has requested me to make the fact known, and I shall therefore be much obliged if you will be so kind as to give insertion to this letter in Nature.

Linnean Society, Burlington House, Piccadilly, W., November 27 — St. George Mivart, Zool. Sec. Lin. Soc.

Does Sargassum Vegetate in the Open Sea?

If the correspondent in Nature, vol. xxi. p. 80, under the above title, would again refer to my communication in vol. xx. p. 578, which I much regret he finds so unsatisfactory, he will see that the several statements and quotations it contains are exclusively based upon "personal" observations made by myself and by the naturalists on board the *Challenger* during our cruise in the North Atlantic in the year 1873. In replying to his inquiries in vol. xx. p. 552, I was only anxious to supply him with what I considered to be the latest and the most reliable information available on the subject, and which hardly deserves to be qualified as "old reports" and as "a mixture of the prevalent opinion since Columbus and observed facts."

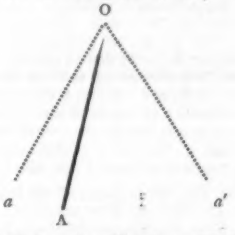
The term *Sargasso Sea* has been extended by geographers, and not incorrectly so, to all oceanic areas where large aggregations of sea-weed are met with, and it does not necessarily imply the presence of Sargassum, *i.e.*, *Sargassum bacciferum* in these regions, since the original Spanish word *Sargazo* (in Portuguese *Sargaço*) simply means "sea-weed." I am, therefore, not surprised that the correspondent should not have found any gulf-weed while crossing the Pacific Sargasso Sea.

Nor can the obscurity in which so many details connected with the gulf-weed are still involved be fairly ascribed to want of observation on the part of the few naturalists who have had the opportunity of studying this interesting alga *in situ*, that is to say, in the middle of the North Atlantic, but rather to the great difficulty, if not impossibility, of ascertaining the life-history of a specimen accidentally found floating on the surface of the ocean. For this reason I fear that some time may elapse before the numerous questions put by the correspondent in vol. xxi. pp. 80–81 can be satisfactorily answered. A botanist stationed for several seasons at Bermudas, or on one of the Bahama Islands, might probably succeed in throwing some light upon the successive stages in the growth and decay of *Sargassum bacciferum*.

J. J. Wild

The Paces of the Horse

I venture to offer the following illustration of the effect produced on the eye by a horse galloping.



I take a pencil, O A, and oscillate it rapidly between the positions O *a* and O *a'*. The impression produced on my eye is an indistinct fan-shaped figure, *a* O *a'*, bounded by two rather distinct images of the pencil in its extreme positions O *a* and O *a'*. The indistinctness of the fan-shaped figure is caused by the rapid change of position of the pencil, which is reduced to a minimum at O *a* and O *a'*, where the pencil swings up to, and returns back from, its extreme positions, passing over the same ground twice in successive instants of time, and thus seeming to pause in the immediate neighbourhood of those positions. An artist representing this effect would draw the indistinct fan-shaped figure; and the two rather distinct images of the pencil at O *a* and O *a'*.

The relative motion of the legs of a horse galloping may be looked upon as that of rapidly oscillating pendulums with this very important addition; that besides their pendulum-like oscillations, they go through rapid *internal* changes of form, owing to the bending, or doubling up, of the legs at the knees, hocks, and fetlocks, at every stride. The rapidity of these internal changes is reduced to a minimum when the leg is in its extreme *outstretched* position. Again, it is in this same position that the rapidity of change of position owing to the pendulum-like oscillation is also at a minimum. The two minimums are, as it were, *coincident*, and, as a consequence, every leg as it reaches its outstretched position, seems for an instant to pause, leaving a rather distinct impression on the eye. The other legs on successively reaching their respective outstretched positions produce corresponding impressions on the eye. It is a fact that the legs do not reach these positions *simultaneously*; they reach them *successively*, but the image produced by one leg in its outstretched position has not time to be obliterated before the images of the other legs are produced in their corresponding outstretched positions. Therefore they appear to us to be all simultaneously in those out-

stretched positions, and it is thus that the artist should represent them. It is his duty to represent things as they *appear*, rather than as they actually *are*, at a given instant of time.

The fan-shaped form noticed in the case of the oscillating pencil becomes exceedingly indistinct, if it does not disappear altogether, in the case of the galloping horse's legs. This is owing to the rapid internal changes of form of the legs.

Your correspondent, Sir W. G. Simpson, Bart., states in his excellent letter produced in NATURE, vol. xxi. p. 55, that a galloping horse might be represented with all its legs gathered under it. I venture to disagree with him for this reason: the two "minimums" to which I have referred in a former part of this letter are *not* coincident when the legs are in their extreme position gathered under the body, and therefore no such distinct image of them in that position is produced. The "minimums" are only coincident in the other extreme, viz., the outstretched, position.

The artistic representation of a horse's paces other than galloping, as also that of other objects in motion, can be determined by similar reasoning. V. B. BARRINGTON-KENNETT

15, Hyde Park Gardens, W., November 26

Force and Momentum

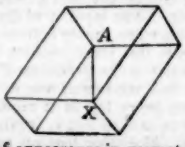
IT is commonly said that change of momentum is evidence that force has acted or is acting on the mass, and that the rate at which the momentum is changing is the measure of the force. Thus, in his lecture on "Force," Prof. Tait says: "Force is the rate of change of momentum" (NATURE, vol. xiv. p. 462). This is not true if the mass be variable. Suppose a sphere of ice moving with constant velocity in a straight line through hot space. The mass, and therefore the momentum, is changing at every instant by the evaporation of the ice. The evaporation being supposed uniform over the entire surface, any force impressed on the sphere by the mutual repulsion between it and a particle of vapour thrown off at a point, p, is balanced by an equal force at the other end of the diameter through p. Hence, the resultant of all these forces is nothing. Here, then, we have change of momentum of the sphere, although no force acts on it. In like manner the change of momentum of a rocket and of a locomotive engine is partly due to change of mass. Does it not hence appear that change of *velocity* is the proper evidence of the action of force? When a variable mass, m, is in motion, the proper measure of the force acting on m at any given instant in any given direction is—not the rate of change of momentum, but—the product of the value of the mass at that instant, and the value of the rate of change of the velocity at that instant and in that direction, *i.e.*, the measure of the force is not $\frac{d(mv)}{dt}$, but $m\frac{dv}{dt}$.

E. G.

[There is no such thing in nature as a "variable mass"; and our correspondent's difficulty arises from his omitting to take account of the momentum of each of the parts (however small) into which a mass may be divided. In most good works on dynamics he will find the motion of a rocket, or of a descending rain-drop (which gathers mass as it falls), accurately treated on the assumption that the momentum produced per unit of time is the measure of the force acting.—ED.]

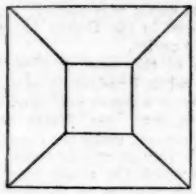
Change in Apparent Position of Geometrical Figures

THE perplexing illusion to which Mr. Bellamy refers (NATURE, vol. xx. p. 362) has long been known, and various explanations have been given of it by physicists. Sir Chas. Wheatstone, in 1838, showed clearly that it is a mental operation, while combating the idea of Prof. Necker, of Geneva, who attri-



buted the alteration of appearance in geometrical figures, not to a mental operation, but to an involuntary change in the adjustment of the eye for obtaining distinct vision. Necker's experiment is substantially the same as that described by Mr. Bellamy. The solid angles at A and X being alternately looked at, sometimes one and sometimes the other appears the nearer, the entire figure at the same time changing in unison; and as Wheatstone points out, "the change of figure frequently occurs while the eye continues to look at the same angle."

In the following experiment it is seen more clearly still that the operation is a mental one, because there is neither movement of recti, oblique, nor ciliary muscles. Two concentric squares have their corners joined by straight lines. The lesser square



will appear in a plane anterior, or posterior to the larger, according as we regard the figure as the representation of a truncated pyramid, or as the representation of a room with its sides all sloping away to the distant square wall. Here no eye muscles are concerned; the image on the retina remains unaltered, and the only operation is a mental one, a turning to the results of past experience. WM. ACKROYD

Mutual Attraction of Spectral Lines

I DO not know that it has been remarked that a line in the diffraction-spectrum (whether bright or dark) must be shifted from its normal position in case another line falls very near it. Neighbouring lines must be attracted if both are bright or both dark, and repelled if one is bright and the other dark. The reason is that the lines are only maxima or minima of light, and the differential coefficient of the sum does not vanish at the same points as the differential coefficients of the separate terms. The shifting will be the greatest in the case of a faint line near a very intense one. I have succeeded in this way in shifting the positions of lines by measurable amounts (1″ to 2″).

Baltimore, Md., November 14 C. S. PEIRCE

EXPLORATION OF TIMOR

IT will be perhaps of some interest to the readers of NATURE to hear that Mr. Riedel, the Dutch resident on Timor (Timor Kupang), who formerly lived on Celebes, and collected a great deal on this island for European museums, and who is known by his various writings on different scientific questions concerning the East, has just returned from a twenty-five days' journey through Central Timor from 123° 30′—125° E.L., as he wrote to me in a letter dated October 6. No European has made such a journey through Timor before, and it has been very troublesome. But the country is, Mr. Riedel remarks, a splendid one, and very suitable for coffee and cinchona cultivation. The traveller did not see any Negritos, who, according to the assertion of M. Hamy, live in the interior of Timor, nor did he hear anything of a Casuary which was reported from there recently. Mr. Riedel collected many geographical notes, and sketched a map of the parts which he visited. A small collection of plants was forwarded to me by Mr. Riedel, and I have sent them to Kew, as Prof. Oliver formerly had the kindness to determine several botanical collections of Mr. Riedel's from Celebes. A. B. MEYER

Dresden, November 29,
Royal Zool. Museum

LAND SHELLS OF THE AUSTRAL ISLANDS

THE small island of *Rurutu* (Oheatora of Capt. Cook) is about 320 miles south-south-west of Tahiti; it is eight miles in length, and has an elevation of 1,500 feet, over 100 feet consisting of old coral reefs which have been upheaved to that altitude. Mr. Charles de Gage, a resident and experienced naturalist, has collected a number of land-shells, which have been studied

by Mr. Andrew Garrett, and described in the *Proc.* Acad. Nat. Sci. Philadelphia. One of the most interesting species is *Partula hyalina* (Broderip), found abundantly in three groups of islands. In Tubuai, 100 miles east of Rurutu, it is abundant, and the Austral group appears to be its metropolis. It is found, though sparingly, in nearly every valley in Tahiti. It was also obtained by Mr. Garrett at Mangaia, one of the Cook's, or Hervey Islands, 400 miles *west* of Rurutu. The variation in examples from the three groups is remarkably slight. It is a strictly arboreal species, and has a uniform white colour.

Another species, *Stenogyra juncea*, Gould (sp.), is found very widely through Polynesia, in all groups north of the equator, and south of all islands from the Marquesas and Paumotus, to the Viti group, and probably ranging further west; they are found under loose stones, beneath decayed wood, among dead leaves, &c., and range from near the sea-shore to 2,000 feet above the sea. Another well-known genus, *Succinea*, is now recorded from Rurutu, slightly differing from a Tahitian species, *S. pudorina* (Gould).

Chondrella (Pease) is remarkable for having no tentacles; during locomotion the animal is nearly or quite concealed by the shell, which is carried diagonally. In creeping, only the extreme tip of the muzzle is seen from above, while the eyes are plainly visible through the transparent shell. The extreme interest of the fauna of oceanic islands becomes continually more evident.

DISTINGUISHING LIGHTS FOR LIGHT-HOUSES

SIR WILLIAM THOMSON writes a long letter on this subject to the *Times* of Tuesday, the letter being the result of a most interesting experimental cruise of ten days on board Her Majesty's ship *Northampton*, in the English Channel, from which he has recently returned, having had many good opportunities of observing the lights on the south coast of England. This has revivified his conviction of need for a threefold reform in our light-house system, which he has been urging and re-urging since 1872 with hitherto but partial success:—A great quickening of nearly all revolving lights; the application of a group of dot-dash eclipses to every fixed light; and the abolition of colour as a distinction of lighthouse lights, except for showing dangers and channels and ports by red and white and green sectors. Of about 120 revolving lights on the English, Scottish, and Irish coasts, there are in all eighteen in which the periods are ten seconds or less and the times of extinction seven seconds or less. In these quick revolving lights the place of the light is not practically lost in the short intervals of darkness; the eye sweeping deliberately along the horizon, with or without the aid of a binocular, to "pick up the light," passes over less than the breadth of its own field of view in the period of the light, and thus picks it up almost as surely and quickly as if it were a fixed light. And so in respect to compass bearings, whether taken roughly and quickly by inspection or more accurately by azimuth compass, the bearing of the ten-second or quicker revolving lights is taken almost as easily and accurately as if the light were continuous. Sir William contrasts this with the case of the ordinary minute-period revolving light, or even the half-minute period to which some formerly slower lights have been quickened. He shows how difficult it is to pick up these slow lights, and his own experience proves that a fixed light like the Eddystone is much more valuable than the slowly revolving Start.

The Wolf light he found most irregular in its periods, the successive periods of light varying from nineteen to forty seconds, and of darkness from nineteen to thirty-four. These irregularities are apt to lead to most serious mistakes, as Sir William shows.

"Except in one unimportant case—the Dungeness Low Light, which flashes every five seconds—all the revolving lights of the English Channel are too slow, and it would be an unspeakable improvement if, with that exception, every one of them had its speed sextupled. There is no mechanical difficulty in the way of doing this. Generally the same mechanism would suffice with a mere change of adjustment of the governor; but the lightkeeper would have to wind up the weight oftener or longer.

"Revolving lights are, however, but a small minority of all the lighthouses of the world. Of the 623 lights of the British and Irish coasts, just 110 are revolving lights, and the remaining 513 are fixed, and there is a crying want of distinction for fixed lights. The distinction by colour alone ought to be prohibited for all lighthouse lights, on account of its liability to confusion with ships' and steamers' side-lights. Southsea Castle, with its red and green port and starboard side lights, seems as if actually planned to lure on to destruction an unsuspecting enemy carefully approaching the coast with Thomas Gray's happy rule well impressed on his mind:—

"'Green to green, and red to red,
Perfect safety, go ahead.'

He does so, and is wrecked on Southsea beach.

"My proposal for supplying the want is to distinguish every fixed light by a rapid group of two or three dot-dash eclipses, the shorter, or dot, of about half a second duration, and the dash three times as long as the dot, with intervals of light of about half a second between the eclipses of the group, and of five or six seconds between the groups, so that in no case should the period be more than ten or twelve seconds. This proposal has been carried into effect with perfect success in Holywood Bank Light, Belfast Lough, now the leading light for ships entering the Lough, but which until 1874 was inclosed in a red glass lantern and was only visible five miles, and was constantly liable to be mistaken for a sailing vessel's port side light entering or leaving the harbour of Belfast, or the crowded anchorage of Whitehouse Roads. In 1874 the red glass was removed, and the light was marked by dot, dot, dash (— — ———, or letter U), repeated every ten or twelve seconds, and has been so ever since. It is now recognised with absolute certainty practically as soon as seen in ordinary weather from the mouth of the Lough, ten miles off, and has proved most serviceable as leading light for ships bound for Belfast or entering the Lough.

"It is much to be desired that the dot-dash system should be seriously considered by the lighthouse authorities of our islands. Hitherto, when attention has been called to it, it has been dismissed with a pleasantry, 'Winking lights won't do,' or else something utterly different has been gravely considered and justly condemned. It is satisfactory now to know that the Deputy-Master of the Trinity Board, Sir Richard Collinson, K.C.B., has, after its character was correctly put before him by the recent Select Committee of the House of Commons on Electric Lighting, given it his approval in the concluding answers of his evidence."

The *Times*, in commenting on Sir William Thomson's letter, speaks of the subject as one of great national importance, Sir William speaking with the twofold authority of a distinguished man of science and of a practical yachtsman. The *Times* endorses emphatically all Sir William's recommendations, and insists especially on doing away with colour as a distinctive feature of lights.

"If," the *Times* concludes, "the recommendations of Sir William Thomson should eventually lead to a reform of this importance and magnitude, he will be a benefactor to humanity; but even without this his advice cannot fail to commend itself to navigators. It bears one of the most distinctive marks of genius—simplicity; and now that it has been brought fairly under the notice of the public, we may confidently hope that in the future, what-

ever may have been the case in the past, it will not have to contend against that love for 'the thing which has been' which in all periods of history has afforded a distinguishing characteristic of the average official intelligence. In a nation of sailors and yachtsmen a suggestion for the improvement of lighthouses and for the greater safety of shipping ought to be certain of speedy and complete consideration upon its merits alone."

THE TURKOMANS

AT the meeting of the Anthropological Institute on November 23, there was read a short but suggestive paper on these wayward children of the desert, contributed by Prof. Arminius Vambéry. The learned writer, who has perhaps as great a personal knowledge of Eastern nations as any man living, regarded the Turkomans as on the whole the purest and most representative branch of the widespread Tûrki family and described their outward features as quite distinct from the Mongolian. His account was somewhat vague, but the inference evidently was that they belonged in his opinion ethnically to the Caucasian rather than to the Mongolian group. Nor did he attribute this to the gradual absorption of Iranian elements, but, on the contrary, stated that intermarriages with Persian women were much less frequent than is usually supposed, and that the Turkomans are now what they always have been, men of medium stature, like the Kirghizes and unlike the Usbegs and Osmanlis, amongst whom tall individuals are far from rare, with straight or but very slightly oblique ("almond-shaped") eyes, handsome regular features and fair complexion. He further stated that the Turkoman language was also one of the very purest Tûrki tongues still spoken, so much so, that an ordinary Seljukian Turk of Asia Minor would have less difficulty in conversing with a Tekke or Yomut Turkoman than with his nearer neighbours the Turki nomads of Azarbijan and other parts of Persia. In fact, such is the purity of their speech, that the Rev. James Bassett, of the American Mission at Tehrân, is now putting through the press in London his translation of St. Matthew's Gospel in the Jagatai Tûrki for the special use of the Tekke Turkomans. Jagatai, it need scarcely be remarked, is one of the most cultivated of all the Tartar tongues and is still current in Bokhara, Khiva, Ferghana, and parts of Kashgaria. In it are written the Emperor Baber's memoirs, and being less affected by Arabic and Persian elements than the Osmanli of Constantinople, it may be taken as, on the whole, the most representative of Tûrki idioms. On the other hand, the Tûrki belongs undoubtedly to the same great linguistic connection as the Mongolian, both being recognised by modern philologists as collateral, though independent, members of the so-called Finno-Tataric or Ural-Altaic family of languages. Hence Vambéry's description of the physical characteristics of the Turkoman race places them in a sufficiently anomalous position from the anthropological point of view, in so far as they would seem to belong ethnically to the Caucasian, but linguistically to the Mongol stock. Such anomalies are, no doubt, common enough, and instances abound of peoples having changed their language and adopted that of the races by whom they may have been subdued or otherwise influenced. But in the present case the difficulty cannot be got over in this way, nor is it pretended that the Turkomans have adopted a Mongolian form of speech, or indeed that they ever spoke any other language than Tûrki. But Tûrki and Mongolian being offshoots of the same organic tongue, it follows that both races must have had a common origin, and that the Turkomans have since become differentiated from the ethnical, while retaining the linguistic connection. Now this is entirely at variance with the commonly-accepted doctrine that physical traits are always more persistent than speech, in other words that, assuming absolute isolation, the process of linguistic will always be more rapid than that of racial evolution.

In the abstract this is no doubt true enough, but practically there is no such thing as absolute isolation in the present stage of the world's history. Least of all can it be predicated of the Turkomans, who are intruders from the east or north-east in their present habitat, who must have absorbed far more Iranian blood than Vambéry is inclined to admit, and who, instead of being the purest representatives of the Turki race, seem really to be a mongrel people, the outcome of fusion of Mongolian and Caucasian elements in Hyrcania, Bactriana, and the Lower Oxus basin. It must be remembered that the whole of this region, as far north at least as the 40th parallel, formed an integral part of the ancient Persian Empire, and the presence of numerous Iranian communities still speaking Persian dialects both in the lowlands and highlands of Turkestan (Tajiks and Galchas) sufficiently proves that this region was fairly occupied by peoples of Iranian stock, if, indeed, it was not their primitive home, before the arrival of the Turki race driven still westwards by the Mongolians of the Gobi. When the Persian power was finally broken by the Arabs, Turki hordes easily took permanent possession of the Atrek and Murghab Valleys, as well as of the Lower Oxus; but in so doing they gradually absorbed as much Iranian blood as to have in course of time become largely assimilated to the Caucasian type. The same fate overtook their Seljukian brethren in Asia Minor and the Balkan peninsula, all of whom have everywhere become largely Aryanised, and have thus collectively contributed to produce the impression, shared by Vambéry with many ethnologists, that the Tûrki and Mongol types were originally distinct. They themseves have always rightly looked on each other as brethren, and although no importance can be attached to the tradition of a legendary Tûrk, son of Japhet, whence both sprang through the twin brothers Tatar and Mongol, it nevertheless points, like so many other national myths, at a fundamental truth.

Nor are the Mongolian traits so far effaced from the Turkoman race as Vambéry would have us suppose. In "Clouds in the East" Valentine Baker, an equally careful observer, describes them as "muscular, heavy-limbed men, with large hands, rather flat, broad faces, and small eyes, thus showing much of the Tatar type" (p. 212). He even expresses his surprise that it should still be so distinctly marked, "as they constantly capture Persian girls, who become their wives, and so must bring a strong infusion of Persian blood into the race" (*ib.*).

The genuine Tûrki type, however, is still best exhibited in the Kazaks, or, as they are more frequently called, the Kirghizes and Kara-Kirghizes of the West Siberian steppes and Pamir table-land. These Kirghizes speak a pure Tûrki dialect, and because of their distinctly Mongolian features—square, flat face, high cheek bones, oblique eyes, large mouth, &c.—they are supposed to be Mongolised Tatars by those who hold the two types to be originally distinct. But the supposition is entirely gratuitous, and although they may have been to some extent affected by Mongolian elements during the incessant migrations of the Central and Eastern Asiatic nations, there is nothing in their appearance to imply any profound modification of their outward features, while their Tûrki speech militates against the assumption. They resemble the Mongolians because both were originally one, and because in their present homes between Kulja and the Ural Mountains they came in contact with no foreign elements by which the race could be seriously affected. In the Kirghizes we therefore recognise a living proof of the primordial identity of Turk and Mongol.

The transition between the Kirghizes and Turkomans is formed by the Kipchaks of Khokand and other parts of Eastern Turkestan, who, though often classed with the

Mongolian Buryats,[1] are of the genuine Tûrki stock, and speak a pure Tûrki language, though rude and marked by some distinct features.

Touching the numbers and strength of the Turkoman tribes proper, opinions vary considerably. While Behm and Wagner reckon them at no more than 450,000, Vambéry still adheres to the number of one million given in his "Travels in Central Asia," adding that further research may tend to increase, but certainly not to diminish that figure. This estimate is partly borne out by Gen. Obrutcheff,[2] who makes them amount in 1874 altogether to about 930,000, exclusive of the "Eski-Turk" and other scattered members of the family in Asia Minor, North Syria, the Euphrates Valley, and Persia.

In view of recent and pending political events, the subjoined list of the Turkoman tribes with their localities and approximate numbers may be acceptable :—

	Tribe.	Population.	Locality.
Tekke	Akhal	300,000	N. slopes Kuren-dagh and on Tejend River (Lower Herirûd).
Tekke	Merv		Merv Oasis.
	Goklan	55,000	Upper Atrek, Gurgan, and Simbur, and in Mazanderan.
Yomut	Atabai	135,000	S.E. Coast Caspian, eastwards to Kizil-Arvat, and on Lower Oxus below Khiva.
Yomut	Jaffarbai ...		
	Ersari	300,000	Left bank Oxus, about Charjui ; hence called "Lebâb" or "River" Turkomans.
	Al-Ili	15,000	Between Oxus and Afghan frontier.
	Chaudor	30,000?	Ust Urt plateau, east from N. end Caspian.
	Salor	20,000	About the Murghâb between Merv and Herat.
	Sarik	40,000	Merv Oasis.
	Sakar	10,000	About Sarakhs.
	Essen-Ili	115,000	South from the Chaudor.
	Amr-Ili.....	15,000	About Middle Oxus.
	Ui and Aimak	7,500	N. frontier Hazarajat.
	Kara Dashli...	7,500	
	Kozanli.....	20,000	Kozen Dagh (Taurus).
	Pekmeshli...	30,000	Euphrates Valley and N. Syria.
	Genkani ...		
	Kecheli.....		
	Bejeli		
	Rehanli.....		
		1,100,000	

The discrepancy between this estimate and that of Obrutcheff is due to the fact that in the above list are included the Turkoman nomads of Asiatic Turkey, besides a large branch of the Goklans, some 8,000 families, now settled in Mazanderan.

A. H. KEANE

DISCOVERY OF A GASEOUS NEBULA

THE Rev. T. W. Webb writes as follows to the *Times* on the subject of Lord Lindsay's letter in NATURE last week :—

On the night of November 14, while sweeping in the constellation Cygnus with a low power on my 9·38 inch silvered speculum by With, I perceived an object resembling, but not quite identical with, a bluish 9 magnitude star. The use of higher magnifiers at once detected the existence of an ill-defined bright disk, subtending about 4″, and surrounded perhaps with a slight amount of glow. It has since been identified at other observatories as No. 4,004 in Argelander, + 41, the place for 1880 being R.A., 21h. 2m. 31s.; D., + 41° 45′·3. Through the kindness of Dr. Copeland, by whom it has been carefully examined under the greatest instrumental advantages at Lord Lindsay's observatory at Dunecht, North Britain, I am enabled to add the following interesting particulars. It is not circular, and has a sharp nucleus near the north-preceding edge, with a faint effusion of light in the opposite direction. Three very measurable bright lines were found in a powerful spectroscope, of which the positions, as given by two sets of measures, were respectively 500·1, 495·7, 487·0, and 500·1, 495·6, 486·0. When these values are compared with those deduced by D'Arrest from the results of several observers of known objects of this nature—500·4, 495·7, 486·1—there can be no remaining doubt that the object in question is of the very interesting and mysterious class termed planetary, or, more correctly, gaseous nebulæ. Dr. Copeland assigns 8, 5, and 1, as the approximate intensities of these lines, reckoning from the least refrangible direction. It can occasion no surprise that its true characters should have escaped the piercing and practised gaze of Argelander, as it would require a much larger instrument than that which he employed to give any intimation of its nature.

A NEW PLANETARIUM

SIGNOR N. PERINI, of Garrick Chambers, Garrick Street, has invented a planetarium, which, so far as we are aware is in all respects superior to, more *vraisemblable* than, any apparatus of the kind hitherto attempted. The structure, for such it really is, consists first of a hemispherical dome, fourteen feet in diameter at the base and the same in height, resting on twelve columns. Getting underneath the dome, one sees the vault overhead coloured so as to represent the starry sky, with the milky way and the constellations in their proper places. Suspended from the top by a narrow hollow rod is an opal globe lit up by gas or electricity to represent the sun, and around this, at their proper proportional distances, are suspended by almost invisible wires, the planets from Mercury to Uranus. By a slight turn of a key Signor Perini sets the solar system in motion, when the sun revolves on its axis, and all the planets in their proper *elliptical* orbits and at their proper axial inclination, and with proportionate velocity. Saturn has his rings and the other planets their moons ; the earth, about the size of a walnut, by a mechanism peculiar to itself, revolves on its axis at a rate accurately proportioned, the same mechanism causing the moon, a small pearl, to revolve round the earth in its own proper orbit. Round the base of the dome the various signs of the zodiac are indicated, and the paths of the planets are shown by ellipses traced around the vault. The spectator is supposed to be standing somewhere underneath the solar system, and the general effect is very striking. To us it seems the most effective method hitherto devised to convey to old or young a realistic conception of the arrangement and motions of the planets. During the working of the mechanism not a sound is heard, though above the dome, and concealed from view is an elaborate arrangement of machinery. This machinery is of the nature of clockwork, with, however, a special feature by means of which the elliptical motions of the planets are effected. Inside the earth is a watchwork arrangement, which could easily be adapted to the other planets were it not for the expense. When wound the machinery can be kept going continuously for upwards of five hours ; it can be stopped at any moment. The invention has, we believe, cost Signor Perini seven years' unremitting work and seven hundred pounds expenditure. We believe that the work has all been done

[1] "Le nom de Bouroute leur est absolument inconnu" (Ch. de Ujfalvy in *Bul. de la Soc. de Géographie* for June, 1878).
[2] In the Russian statistical work, "Sbornik," iii. p. 80.

at night and during early morning hours, as the inventor has to give his daytime to his profession of teacher. Signor Perini informs us that he could without difficulty make his planetarium as large as the Albert Hall and small enough to become a school apparatus for teaching. He showed us a table, like a small writing-table, between the tops of which he had arranged his machinery on a small scale to give motion to a tellurium which he fits on to the table. Of course the invention, as indeed Signor Perini admits, may be capable of improvements in detail, but as it stands it seems to us a triumph of ingenuity and determined perseverance, for which its inventor deserves the highest credit.

A MICROSCOPIC SERENADE[1]

O COME, my love, and seek with me
A realm by grosser eye unseen,
Where fairer forms will welcome thee,
And dainty creatures hail thee queen.
In silent pools the tube I'll ply,
Where green conferva-threads lie curled,
And proudly bring to thy bright eye
The trophies of the protist world.

We'll rouse the stentor from his lair,
And gaze into the cyclops' eye;
In chara and nitella hair
The protoplasmic stream descry,
Forever weaving to and fro
With faint molecular melody;
And curious rotifers I'll show,
And graceful vorticellidæ.

Where melicertæ ply their craft
We'll watch the playful water-bear,
And no envenomed hydra's shaft
Shall mar our peaceful pleasure there;
But while we whisper love's sweet tale
We'll trace, with sympathetic art,
Within the embryonic snail
The growing rudimental heart.

Where rolls the volvox sphere of green,
And plastids move in Brownian dance,—
If, wandering 'mid that gentle scene,
Two fond amœbæ shall perchance
Be changed to one beneath our sight
By process of biocrasis,
We'll recognise, with rare delight,
A type of our prospective bliss.

O dearer thou by far to me
In thy sweet maidenly estate
Than any seventy-fifth could be,
Of aperture however great!
Come, go with me, and we will stray
Through realm by grosser eye unseen,
Where protophytes shall homage pay,
And protozoa hail thee queen.

JACOB F. HENRICI

[1] From *Scribner's Monthly Magazine* for November.

JOHN ALLAN BROUN

IT is only a few weeks ago that it became our painful duty to record the untimely death of a distinguished mathematical and experimental physicist, and we have now to mourn the loss of one equally distinguished in observational inquiry. John Allan Broun was born at Dumfries, where his father had, we believe, a normal school especially intended for young men about to enter the navy. Upon the death of his father, Mr. Broun, then about twenty years of age, went to the University of Edinburgh, and speedily became a successful student in more than one branch of knowledge. But his strongest attachment was always to physical science, and the late James D. Forbes, who was at that time Professor of Natural Philosophy at Edinburgh, considered Mr. Broun as one of his very best pupils. A friendship was thus formed which lasted through life.

About 1842 the scientific world began to perceive the necessity of conducting cosmical inquiries, and Sir Thomas McDougal Brisbane, in the most generous manner, agreed to establish and maintain a magnetical observatory at his residence at Makerstoun. Prof. Forbes had thus the opportunity of recommending his pupil, Mr. Broun, to Sir Thomas, who gave him the directorship of his observatory. In this capacity he continued to reside at Makerstoun for some years, where the delight of pursuing an occupation congenial to his tastes was enhanced by the great pleasure he derived from the society of Sir Thomas Brisbane, and of his amiable family, and their loss one after another was a very severe trial to him. It was no slight task to superintend an institution such as this in a branch of science then comparatively new, and Mr. Broun laboured so hard at his duties that he began to have palpitation of the heart, caused, probably, by his constant night watches. In consequence of this he obtained as his assistant Mr. John Welsh, who became one of his warmest friends, and who afterwards, as Director of the Kew Observatory, won for himself a high reputation in the course of a life that was, unhappily, very short.

Mr. Broun left Makerstoun in 1850 and went to Paris, where he formed the acquaintance of the lady who was afterwards his wife, Isaline Vallouy, the daughter of a clergyman in the Canton du Vaud, and belonging to an old Protestant family of Dauphiné (du val Louise) who had fled from France at the Revolution. This lady is now left to mourn his loss. From this marriage he had three sons and two daughters. Of his sons one is an architect, one has just left this country to enter upon his duties as civil servant in the North-West Provinces of India, while another, in preparation for the Indian forest department, is finishing his studies at Nancy. In 1851, through the influence of his friend, Col. Sykes, Mr. Broun was appointed director of the Trevandrum Observatory, an institution supported by His Highness the Rajah of Travancore, and he left this country for India in the same year. Of the scientific value of his work in India we will speak later on; but we may remark that it was

attended with many difficulties. He wished amongst other things to have observations at different heights, and the great difficulties which the carrying out of this plan required have been more or less recorded in his various reports. We say more or less, for it may be questioned whether his reports, so admirable in every other respect, do full justice to himself and to those difficulties which he successfully overcame. Mr. Broun, we believe, advanced on his own responsibility the funds necessary for this experiment, but he was afterwards reimbursed. A deafness which never left him began in one of his excursions on the hills with these objects in view. He had been observing all day in the hot sun—in the evening he took a bath and got a chill from the hill breeze after it. He came back to Europe in 1866 in the hope that medical treatment might remove his deafness, returning to India for three years more.

After having finally left India he resided first in Lausanne in Switzerland, and then in Stuttgart in Germany, where his whole time was devoted to the preparation of the first volume of the results of the Trevandrum observations. This cost him an immense amount of labour without rest or recreation of any kind, except perhaps an hour or two devoted in the evening to music with his family. He was a skilled violinist, and was particularly fond of Beethoven's music. In London, where he resided for the last six years of his life, he gave his whole time and energy to the prosecution of the work he had in hand, so much so that even in taking a walk the subject would always be present to his thoughts. Two years ago his health began to give way, and he left London for the New Forest, a change which seemed for a time to be of service to his health. But again, after another year, he found that continued work was affecting his brain, and during a stay at Lynton (Devonshire) he had in 1878 a kind of nervous attack, which was the beginning of his last illness. He never altogether rallied after this attack, and was much distressed last winter at being obliged to cease from all work, but he bore this trial with much meekness and gentleness of manner to all around him.

Being rather worse in the spring, he made up his mind to go to Switzerland in search of strength, and after a few weeks of much weakness spent at Bex, he began to rally and to enjoy the walks in that beautiful neighbourhood. From there he went to Finhaut, Chamouny, and Tête Noire, and greatly enjoyed his daily excursions in the mountain paths and over the hills; indeed he used to say that they made him feel quite young again. At first after his return to London he complained of his head, but he seemed stronger again just before his death, and worked a few hours daily. He had begun an article for NATURE, and assured his family that he did not overfatigue himself. On the 22nd of last month he died suddenly. He took up the newspaper in the morning to glance at it near the fire. He had not done so for five minutes when he said, "I think I am going to faint." Medical aid was at once procured, but he had a kind of suffocation for two or three minutes, and all was over.

In reviewing the life and labours of John Allan Broun it is impossible to fence off that portion of his character which relates to science, and discuss it without reference to the other parts of his nature. To do so would be to throw away the key of the very chamber which we wish to enter.

He was a man of the most scrupulous integrity, of the most sensitive conscience. But this extreme scrupulosity did not prevent him from appearing in the most amiable character to his fellow men; for he was at the same time a man of the most delicate social instincts, and eminently qualified to shine in society; a very warm friend and a very good companion. If any one suffered from his scrupulous nature it was himself, or, to speak more properly, it was that portion of his surroundings which goes by the name of "material interests." It is of course a mistake to suppose that the highest interests of any man can ever suffer from his being honest.

He was a devoted adherent to the Free Church of Scotland, and at a time when subscription to certain formulæ was insisted on from the professors at the Scottish Universities, his conscientious scruples stood in the way of his obtaining any appointment of this nature. Had it not been for these he might, no doubt, have had the chair of Practical Astronomy at Edinburgh, or that of Natural Philosophy at St. Andrews.

And here we may be permitted to quote a few sentences from a letter written by Prof. Forbes to Sir James Graham (then Home Secretary) urging the claims of Mr. Broun to the former of these posts. After describing the scientific qualifications requisite for an astronomer, he goes on to say:—"But beyond all these may be reckoned a conscientious zeal in the discharge of a duty, often irksome, generally solitary, without which the observatory establishment is not only useless but injurious. In these respects I can cordially recommend Mr. Broun to the favourable notice of Government from more than six years' intimate acquaintance with him. . . . He was subsequently selected by Sir Thomas Brisbane to direct the noble magnetical and astronomical observatory, erected and maintained by his liberality at his seat near Kelso. . . . You are aware how much labour and ingenuity have been expended in devising magnetic instruments and experiments. You must be aware of the skill and patience required to conduct such experiments, of a kind almost new, and with instruments whose actions and errors are almost untried. Now from frequent examination of Mr. Broun's methods, I think I am justified in saying that not one of the magnetical observatories under the direction of Her Majesty's Government has been more vigorously managed than that of Sir T. Brisbane, conducted by Mr. Broun, and probably none with more intelligence and ingenuity."

We cannot help feeling that during the latter years of his life, while he resided in London, Mr. Broun might have received a somewhat larger measure than was accorded him of generous and sympathetic treatment from those specially interested in the progress of observational inquiry. Possessed of no considerable amount of private means, he was living upon a small pension which he had from the Rajah of Travancore, and which has now expired with him. He had been led to believe that one of his labours after leaving India would be to superintend the reduction of his observations. But the publication of these reductions was discontinued after the first volume of results appeared, and, in consequence, a large mass of valuable observations made at considerable cost is now lying absolutely useless.

Surely the course of action which will establish and maintain an observatory, and then decline to make public the records is only comparable in folly with that of a man who begins to build a house which he is not able to finish.

It was a source of great sorrow to Mr. Broun that he was thus prevented from completing what he might justly consider to be the work of his life, and he then endeavoured to procure some employment by which, while advancing his favourite science, he might likewise add to his somewhat slender resources. About that time the meteorological office of this country was in process of reconstruction and he had thoughts of offering his services as one of the meteorological council. It was clear however that his deafness would be considered by those in power as a fatal disqualification for such an appointment, and in consequence he did not press his claims. It certainly seems a great pity that a national institution of this nature so liberally endowed by government should have allowed a man like John Allan Broun to die in their midst without attempting to avail themselves in some becoming and honourable manner of those large stores of

information peculiarly suited to their purpose which he alone of all men living possessed, and which he was particularly anxious to communicate to others.

About this time too, Sir E. Sabine resigned his office of magnetical superintendent, and it might naturally have been supposed that Mr. Broun was the very man to succeed him. The office was, however, discontinued. He now made application to the Government Fund of the Royal Society for a sum of money to enable him to improve and complete the reduction of the Colonial magnetic observations. But the immediate and apparent responsibility from quarter to quarter of the possessor of such grants, was peculiarly fatal to a man like Broun. The work seemed to go on growing the more he examined it, and he was never satisfied without going still more deeply into the subject than he had already gone.

Then his health began to give way, and the thought that he had received money for which he had rendered no equivalent hastened still more the progress of his malady.

At last the end came, and we can now hope no longer to complete his labours as he would have himself completed them had he been spared to us but a little longer.

It has been said of an eminent experimentalist that great as were his successes, his failures must have cost him even more thought. If this be true in experimental research, it is peculiarly true in observational inquiry where every idea in order to be tested entails a laborious investigation. Mr. Broun, whose mind was very fertile, must have often spent great labour apparently to no purpose, but on the other hand his successes were very marked, and he did not hesitate to consider a new fact as abundant compensation for a large amount of failure. We cannot attempt to give here an exhaustive catalogue of his various labours. But we may allude to the volumes embracing the results of the Makerstoun observations as pre-eminent for the skill employed in the development of new methods. These volumes alone must have cost him an immense amount of thought.

In 1861 he communicated to the Royal Society of Edinburgh, two papers of marked value. In one of these the errors and corrections of the bifilar magnetometer were discussed, including the determination of its temperature coefficient, which Mr. Broun showed might be found in a more correct method than that hitherto adopted.

The second of these papers was on the horizontal force of the earth's magnetism, for which he established the annual laws from a discussion of observations taken at various places. He likewise discovered that the variations of this element from day to day are nearly the same over all the world.

For these discoveries he was awarded the Keith Medal of the Royal Society of Edinburgh. We have already alluded to the great labour he spent upon the first volume of the "Results of the Trevandrum Observations." In this volume conclusions of the greatest scientific interest are deduced, and Mr. Broun has been able to give in a complete form the laws which regulate the solar-diurnal variation of magnetic declination near the equator. But his researches regarding the lunar-diurnal variation of this element form perhaps the most original and interesting part of the volume. He has claims to be considered as an independent discoverer of this variation, and he has certainly increased our knowledge of its laws more than any other magnetician. We may mention his observation that the lunar action was reversed at sunrise and that it was much greater during the day than during the night, whether the moon was above or below the horizon, as particularly noteworthy and likely to throw much light on the theory of the subject. We have already alluded to Mr. Broun's discovery of the similarity, all the world over, of the changes from day to day of the earth's horizontal force. Certain of these changes he found to be due to the moon, while others had a period of twenty-six days. These last he attributed to solar action, and in discussing the subject he found that the greater magnetic disturbances were apparently due to actions proceeding from particular meridians of the sun. This is a subject of very great importance, and its exact meaning has yet to be discovered.

Mr. Broun was no less eminent as a meterologist than as a magnetician. His observations regarding the barometer are of the greatest importance. In this branch of inquiry he has shown the apparent simultaneity of the changes of mean barometric pressure over a great part of the globe, and he has likewise discovered a period of twenty-six days. He was the first to commence those systematic observations of clouds at various altitudes that are now so extensively made, and in a paper read not long since before the Royal Society of London, of which body he was an old member, he pointed out certain relations between atmospheric motions and the directions of the lines of equal barometric pressure. For his various researches, he obtained in 1878, just one year before his death, the Royal Medal of that Society.

These are only a few of the many labours of one whose loss, so deeply felt by all his friends, may be regarded as a calamity by the cultivators of meteorology and magnetism, branches of knowledge in which he was second to none who has yet appeared.

BALFOUR STEWART

NOTES

DR. WARREN DE LA RUE, F.R.S., has just sent to the Chemical Society Research Fund a third donation of 100*l.*, the whole amount to be devoted to a single research.

IN the person of Lady Sabine, who died at Ashley Place on the 28th ult., at the age of seventy-two years, a woman of most remarkable clearness of intellect and of power of memory has passed away. In 1827 she married Sir Edward (then Captain) Sabine, and for more than fifty years her main occupation and her chief enjoyment was to assist him in his investigations, especially in terrestrial magnetism. None but her most intimate friends can know how much of the laborious calculations in the "Contributions" were really effected by her, while she translated Humboldt's "Cosmos" and "Ansichten der Natur," besides numerous smaller papers. One of their oldest friends has truly said, "I deeply sympathise with Sir Edward; the death of his wife has rendered the number of beautiful lives in the world one less."

THE following are the probable arrangements for the Friday evening meetings before Easter, 1880, at the Royal Institution:—January 16, Prof. Dewar, F.R.S.; January 23, Dr. W. B. Carpenter, C.B., F.R.S., "Sea and Land in Relation to Geological Time;" January 30, John Marshall, F.R.S., "Proportions of the Human Figure;" February 6, William Huggins, D.C.L., F.R.S.; February 13, W. H. Preece, C.E., "Wheatstone's Telegraphic Achievements;" February 20, Rev. H. R. Haweis, "Old Violins;" February 27, Frederick J. Bramwell, F.R.S.; March 5, H. N. Moseley, F.R.S., "Deep-Sea Dredging and Life in the Deep Sea;" March 12, C. William Siemens, D.C.L., F.R.S.; March 19, Prof. Tyndall, D.C.L., F.R.S. The following are the lecture arrangements before Easter:—Christmas Lectures (adapted to a juvenile auditory): Prof. Tyndall, D.C.L., F.R.S., six lectures on "Water and Air," on December 27 (Saturday), 30, 1879, January 1, 3, 6, 8, 1880; Prof. Edward A. Schäfer, F.R.S., ten lectures on "The Physiology of Muscle," on Tuesdays, January 13 to March 16; H. Heathcote Statham, two lectures on "Modern Architecture since the Renaissance," on Thursdays, January 15 and 22; Prof. Dewar, F.R.S., eight lectures on "Recent Chemical Progress," on Thursdays, January 29 to March 18; Prof. T. Rupert Jones,

F.R.S., three lectures on "Coal," on Saturdays, January 17, 24, 31; Ernst Pauer, three lectures on "Handel, Sebastian Bach, and Joseph Haydn" (with musical illustrations), on Saturdays, February 7, 14, 21; four lectures on "History of Literature," on Saturdays, February 28, March 6, 13, 20.

AT the request of the Government of the Cape Colony and the trustees of the South African Library at Cape Town, Sir Bartle Frere has desired Prof. Max Müller and Prof. Sayce to select a qualified successor to the late Dr. Bleek, to continue his labours as colonial philologist and as custodian of the valuable library presented to the colony by Sir George Grey. The salary will be 500*l.* a year, of which 300*l.* will be contributed by the Government, and 200*l.* by the committee of the South African Public Library. Applications and testimonials only may be sent to Prof. Max Müller, Oxford.

THE lectures in connection with the Brown Institution will be delivered by Mr. W. S. Greenfield at the University of London on December 17, 18, 19, 22, and 23 at 5.30 P.M. The subject will be "Recent Investigations on the Pathology of Infective and Contagious Diseases."

THE French Minister of Public Instruction has appointed a section of the Commission of Historical Monuments for the purpose of establishing an official record of all megalithic constructions and erratic blocks discovered in France and Algiers.

THE grants voted by the Legislative Assembly of France for 1880 have been sent to the Senate, and according to every probability will be voted without any material alteration. The sum of 59 millions of francs was voted for public instruction, 2½ millions more than were asked for by the Government. In 1870 the grants for educational purposes were 26 millions and in 1851 only 16 millions. Among the items in the grants are the following:—The grant for the National Institute is 707,762 fr., for the Academy of Medicine 75,000 fr., the College of France 466,000 fr., the Museum of Natural History 835,000 fr., for astronomical and meteorological observatories 835,000 fr., for the National Library 674,000 fr., for the National Library and Museum of Algiers 296,000 fr., travelling expenses for explorers 200,000 fr., École des Hautes Études (conducting experiments, &c., &c.) 300,000 fr.

THE Edinburgh Liberals, who have had a week of almost uninterrupted oratory from their idol, Mr. Gladstone, have been impressing science into their service, in order that Mr. Gladstone's voice might reach a much larger audience than any single hall in Edinburgh could hold. On Saturday he addressed an audience in the largest hall in Edinburgh, the Corn Exchange; but as this could not anything like hold the multitude that wanted to hear him, it was connected by telephone with another hall at some distance. We shall let the *Daily News* correspondent describe the result of the arrangement:—"The audience distinctly heard the cheering and singing of the meeting in the Corn Exchange, and also the strains of the band. Lord Rosebery's voice was also recognised, and it was gathered that he was saying pleasant things about Mr. Gladstone. Next came a burst of cheering, the sound of which was suddenly stopped, and a long interval of silence followed, varied from time to time by the murmur of distant cheers. Then as suddenly as silence had fallen, there came the sound of Mr. Gladstone's voice, and he was followed pretty well through 'some remarks on corn averages and the condition of India.' All this, which greatly mystified the telephonic audience, is capable of easy explanation. Observers of Mr. Gladstone's manner in the House of Commons will remember what an important part the right hon. gentleman's hat plays in his great speeches. He invariably places it on the table, a little to one side of him, and on the top of it he places his notes, which he rapidly shuffles and re-arranges as the oration progresses. This afternoon, bringing his hat to the table in his accustomed manner, he unconsciously planted it right in front of the cylinder of the telephone which had been fixed on the table, thus, of course, cutting off the means of communication. As the speech proceeded, he began the re-arrangement of the papers and the movement of the hat, which latter he finally drew away from the telephone, and then became audible in another building a quarter of a mile off, 'some remarks on corn averages, and the condition of India.'" It is a pity Mr. Gladstone had not been put up to the arrangement; we are quite sure, had he known, he would not have adopted so "obstructive" a line of action with his hatful of papers.

A NEW light company has started a public subscription in Paris for 80,000*l.* The inventor proposes to dispense with magneto-electric machines, by resorting to Bunsen elements of special construction, and to dispense with regulators by incandescent light. An immense number of prospectuses have been circulated amongst the peasantry, and the funds are collecting with an amazing rapidity.

Scribner's Monthly, one of the best monthlies anywhere, has an interesting illustrated article in the December number on the Johns Hopkins University.

A COMPETITION having been opened for erecting a memorial of the siege of Paris on the Rond Pont of Courbevoie, M. Bartholdi, the author of the gigantic statue representing the French-America alliance, has executed a model representing a balloon with a sailor aëronaut and the beseiged city receiving messages from a carrier-pigeon. The *ensemble* is grand and picturesque. It has raised the enthusiasm of Paris aëronauts, who are to make a public demonstration in support of M. Bartholdi's schemes.

THE *Colonies* of November 22 contains a long and valuable list of works on Commercial Botany, drawn up by Messrs. G. J. Symons and P. L. Simmonds.

THE new part of Mr. Bentham and Sir Jos. Hooker's "Genera Plantarum" will be published in January, and will complete the Dicotyledonæ. Only one other part, the Monocotyledonæ, will remain to be published.

ON November 21 M. Mariette-Bey read, before the Academy of Inscriptions of Paris, a long report on the new excavations which are to be executed in Egypt. This address having been delivered in a solemn meeting of the Academy, it is certain that the illustrious Egyptologist will obtain a grant from the French Government.

THE *Kölnische Zeitung* says that a rack railway, of the Righi type, will be erected on the Drachenfels, one of the seven hills situated on the left bank of the Rhine. The survey of the intended line is proceeding with activity.

THE Kane Geyser, or spouting water-well, has lately attracted much attention from the sight-seeing public. Some exact data regarding it are furnished in a recent notice by Mr. Ashburner (*Amer. Jo. of Sci. and Arts*, November). The well is situated in the valley of Wilson's Run, near the Philadelphia and Erie railway-line, and four miles south-east from Kane. It was drilled in the spring of 1878 to a depth of 2,000 feet, but, as no petroleum was found in paying quantities, the casing was drawn and the hole abandoned. In drilling, fresh-water veins were met with down to 364 feet, which was the limit of the casing. At 1,415 feet a very heavy "gas-vein" was struck, and this gas was allowed free escape while the drilling was continued to 2,000 feet. When the well was abandoned, the fresh water flowed in, and the conflict between the water and gas commenced. The water flows into the well on top of the gas till the pressure of the confined gas becomes greater than the weight of the superincumbent water, when an expulsion takes place,

and a column of water and gas is thrown up to a great height. This occurs at present at regular intervals of thirteen minutes, and the spouting continues for one and a half minutes. The column, according to measurement, varied in height from 108 to 138 feet. The gas of the mixture can be readily ignited. After nightfall the spectacle is grand. The antagonistic elements of fire and water are so promiscuously blended that each seems to be fighting for the mastery. At one moment the flame is almost entirely extinguished, only to burst forth at the next instant with increased energy and greater brilliancy. During sunshine the spray forms an artificial rainbow, and in winter the columns become incased in huge transparent ice-chimneys.

WE have received the numbers for October and November of the *Natural History Journal* "conducted by the Societies in Friends' Schools." This journal continues to sustain its reputation, and several papers in these numbers are highly creditable.

THE *Colonies and India* states that a new store of guano has lately been discovered in a series of caves about 100 miles east of Cape Town. It is described as being a light-brown powdery mass, in which a number of solid nodules occur. An analysis shows that it contains 68 per cent. of ammonia compounds, 16 per cent. of phosphates, and 2 per cent. of nitrogen. In the same caves are considerable quantities of salts, forming a crystalline mass, and containing 33 per cent. of phosphoric acid, 11 per cent. of sulphuric acid, 15 per cent. of nitric acid, 19 per cent. of potash, and 7 per cent. of ammonia.

CONSUL CALVERT, reporting on the trade and commerce of Alexandria for 1878, thus refers to the new fodder plant, the Téosinté (*Euchlæna luxurians*), which has attracted so much attention lately in tropical countries. During the last three or four years experiments have been made at Cairo and attended with complete success, and it is expected that it will eventually prove to be a great acquisition to Egyptian agriculture. The plant attains the height of from thirteen to sixteen feet, and so rapid is its growth that in an experiment made in July at Cairo the plant after having been mown down grew one foot in four days. On analysis the plant is found to contain much saccharine matter, and to be much more nourishing for animals than the native clover or *verseem* (*Trifolium alexandrinum*).

UNDER the title of "Notes on the Flora of Surrey," a list of plants known to occur in the five adjoining counties, but not really known in Surrey, has been published by Mr. A. Bennett, of 107, High Street, Croydon, who has issued the list "as a first step towards a proposed supplement to the flora of the county, and with the wish that those botanists who may be able to help will kindly do so, either in confirming by specimens any doubtful plants reported for the county, or by giving the localities where they may be gathered, so that search may be made next season." Mr. Bennett's list is a useful one, though the botanical nomenclature has been very carelessly corrected, if indeed corrected at all.

MR. CHARLES GILBERT, of Bedford Street, has published "Tables of Metric Measures and their English Equivalents," by G. M. Barns, for use by engineers, architects, contractors, and others.

WE some time ago announced the death of the librarian of the "Leopoldino-Karolinische" Academy for Natural Sciences, Dr. Behn, of Dresden. The statutes of the Academy prescribe that the library must be at the librarian's place of residence. Consequently the whole library, consisting of some 40,000 volumes, has been transferred to Halle, where Dr. H. Knoblauch is the new librarian.

IN a lecture delivered at Bristol by Mr. Lant Carpenter, he spoke of his recent visit to the United States, and remarked that amongst the various improvements and things which were being tried there, one that struck him as much as anything was the extraordinary development within the last two or three years of the application of electricity to the purposes of practical life. He gave several remarkable examples of the way in which the system is applied in the United States for the protection of safes, vaults, and other valuable property, alarms being rung in a central office whenever a forcible entrance was attempted in any one of, say, 500 vaults, the alarm indicating which one. In many cities and towns in the States, he said, there were district telegraphs established. From a central office wires ran to every private house in the district which wished to be connected, and by this means you could communicate with the central office, and by a prearranged set of signals on a bell, the inmates of the house could call a cab, a policeman, a messenger, or a doctor, by simply pulling a handle. The lecturer, in speaking of the practical application of electricity to a system of fire alarms, explained the general system pursued in all large towns in the United States, and spoke of the extraordinary rapidity with which fire-engines are turned out ready for use on receipt of the electric signal. Six or eight seconds was the usual time. Electric signal boxes were fixed in the streets, and any person, on becoming aware of a fire, could turn a handle and communicate at once with the central stations, where the officials would know from which box the signal came. An automatic system was at work in New York, where 500 shops, stores, and warehouses were protected by an apparatus which sounded an alarm in a central office whenever the temperature of any place rose above a given point. Mr. Carpenter stated that in all large towns in the United States of America there was a system of telephone exchanges established. It was a system by which a large number of persons had these telephones in their houses, the wires of which all converged in a central office, and by such an arrangement any one of the subscribers to the exchange could talk to any other person who was also a subscriber through the central office. The wire from each house ended in the central offices, and by simple arrangements any one wire could be readily joined to any other, thus putting two people into communication. The lecturer gave instances of this arrangement, explaining that so perfectly were these telephones constructed that a person's voice could be readily and easily recognised. The lecturer proceeded to comment upon their recent extraordinary and rapid development in every large town in the United States. The subscribers to these exchanges were numbered by thousands, and their uses and advantages were many. Not only were they now connecting different parts of one town by means of these exchanges, but steps were being actively taken to connect towns together by similar means. In conclusion, the lecturer urged that if science, practically applied, was to form so large a portion of our daily life, was not that a very strong argument for so arranging our educational work that every child should be instructed in the rudiments of science? Dr. W. B. Carpenter, having been invited to address the meeting, said he felt convinced that in the next generation the telephone would become almost as generally used as the telegraph was now, though he did not mean to say the latter would be superseded.

AN interesting Roman structure has recently been discovered at Regensburg (Ratisbon). It consists of a subterranean aqueduct of some 10 metres in length, 1½ metres in height, and 60 centimetres in breadth, built of colossal blocks of stone.

THE additions to the Zoological Society's Gardens during the past week include a Common Wood Owl (*Syrnium aluco*), European, presented by Mr. W. J. Smith; a Turquoisine Parrakeet (*Euphema pulchella*) from New South Wales, presented by Mr. A. Battescombe; a Macaque Monkey (*Macacus cynomolgus*) from India, a Barbary Falcon (*Falco barbarus*) from North Africa, deposited; a Reeves's Muntjac (*Cervulus reevesi*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

A SEVENTH STAR OF THE ORION-TRAPEZIUM.—In addition to the well-known fifth and sixth stars in the trapezium of Orion, the former detected by Struve with the Dorpat refractor on November 11, 1826, and the latter by Sir John Herschel with Sir James South's large refractor at Kensington, on February 13, 1830, the elder Bond, soon after the mounting of the Harvard instrument, perceived, roughly in the direction of the sixth star, a fainter and more distant one, which is No. 24 of his memoir on the nebula published in 1848. M. O. Struve, with the telescope of similar dimensions at Pulkowa, could not see this star, a circumstance which might be attributable either to variability, or to the difference of altitude of the object at Pulkowa and at Harvard College. It was repeatedly observed by G. P. Bond, and is No. 636 of his catalogue printed in *Annals* of the Astronomical Observatory of Harvard College, vol. v., where its magnitude is estimated to be 13·3 on Argelander's scale. The Pulkowa measures gave for the sixth star position 128°·8, distance 3″·73 at the epoch 1858·78; from the Harvard differences of right ascension and declination we find, for the seventh star, position 136°, distance 12″·1. In Bond's later notes the following references to this star, amongst others, occur:—1863, January 19 and 23, difficult; January 30, easy, though faint; February 14, not difficult, though requiring attention and effort. 1864, February 3, under fine definition, though easily seen, probably fainter than in the previous year; February 29, readily seen and possibly brighter. Referring to the notes in 1850 and 1851, it is remarked that the star is "often mentioned in these earlier observations; as *certainly* seen on the dates 1850, February 7, March 2, March 5, March 11; it is not mentioned March 10, and was not seen March 12; not mentioned 1850, December 27, but seen again 1851, February 3." It was observed on several occasions in 1859 and 1860. On January 28, 1861, seen by glimpses, and on February 13 easily. On January 31, 1862, not seen. Some of these observations might appear to point to variability, but others seem to afford "another and quite different explanation of the phenomena." If we are not mistaken, this seventh star has been recently caught up with the Ealing reflector; but there are other telescopes in this country which should be competent to cope with it, and the star may deserve some attention.

LUNAR ECLIPSES.—In the small eclipse of the moon (magnitude 0·17) which will occur on the 28th of the present month, the first contact with the shadow takes place at Greenwich at 3h. 37m. P.M., and the last contact at 5h. 15m.; the moon rises at 3h. 46m. Of the eight lunar eclipses occurring within the following five years, only one, that of October 4, 1884, will be wholly visible in this country. The circumstances of these eclipses may be thus very briefly indicated:—

1880, June 22.—Invisible, the middle at 1h. 50m. P.M.
Dec. 16.—Total; beginning of total phase at 2h. 54m. P.M., the moon rising at 3h. 46m.
1881, June 12.—Invisible, the middle at 6h. 54m. A.M.
Dec. 5.—Nearly total (0·97); first contact with the shadow at 3h. 28m. P.M., the moon rising at 3h. 50m.
1883, April 22.—Invisible, the middle at 11h. 39m. A.M.
Oct. 16.—First contact with shadow at 5h. 59m. A.M., the moon setting at 6h. 25m.
1884, April 10.—Invisible, the middle near noon.
Oct. 4.—Total, visible throughout, the middle soon after 10 P.M.

PARALLAX OF A SMALL STAR.—Dr. Geelmuyden, of the Observatory at Christiania, by a series of observations extending over more than twelve months, finds "a notable parallax" for the ninth magnitude star, No. 11677 in Oeltzen's Catalogue from Argelander's northern zones. This star has a proper motion of 3″·04 in the direction 274°. The parallax appears to amount to about 0″·25, but the result is considered far from definitive. The position of this star is in R.A. 11h. 13m. 49s., N.P.D. 23° 30′ 2 for 1880.

NEW NEBULÆ IN ERIDANUS.—M. Block has detected at Odessa two nebulæ in this constellation, which are not found in Sir John Herschel's General Catalogue, the first in R.A. 3h. 28m. 9s., N.P.D. 116° 16′·5, the second in R.A. 3h. 33m. 48s. N.P.D. 116° 43′·7 for 1880. The former is pretty bright, and five minutes in diameter, the latter "considerably bright," with strong central condensation, and readily observed even with the moon above the horizon. The repeated discovery of uncatalogued nebulæ in these days becomes of much interest in connection with the question of variability.

PHYSICAL NOTES

PROF. STEINHAUSER, of Vienna, has recently pointed out that there exists a determinate relation between the size and relative position of the two views of a stereoscopic picture, the lenses of the camera with which it is taken, and the optical arrangements of the stereoscope in which it is to be viewed. If these relations are observed rightly, the effect of relief will be much more perfectly attained for all parts of the picture than if they are neglected. The eye-pieces of the stereoscope above the plane of the photographic pictures ought to be made as nearly as may be equal to the focal length of the objective of the photographer's camera, and this again should be about equal to the mean distance of easy vision, or, from ten to twelve inches. Herr Steinhauser, after developing the theory of the instrument in relation to this point, throws out three very definite and simple suggestions for the photographers. Firstly, that all stereoscopic pictures should be taken with lenses of equal focal length, say 15 centimetres; secondly, that all should be made of equal breadth, or about 75 millimetres; thirdly, that the distances between the centres of the objective-lenses should always be kept constant.

THE *passivity* of iron when employed as the positive pole of a nitric acid battery, or as positive electrode of a voltameter cell containing nitric acid, has recently been studied by M. Louis Varenne, who concludes that the passive state is due to a film of nitric peroxide which collects upon the surface of the iron and protects it from further chemical action. M. Varenne states that this film is apparent when the surface of the iron is examined under the microscope. He finds that the passive state ceases if a stream of carbonic dioxide or of hydrogen is passed through the liquid, and that solution proceeds apace. He also finds that nitric peroxide gas is evolved from the passive iron when it is placed *in vacuo*.

ANOTHER new instrument may shortly be expected from the *atelier* of Dr. König, which will probably settle for ever the dispute between himself and Mr. A. J. Ellis as to the correctness of his tuning-forks of normal pitch. It will indicate a variation of one vibration in ten thousand from the assigned pitch.

M. PELLAT finds that Latimer Clark's standard cell is not entirely free from variations in its electromotive force. He has found two similar cells may differ from one another by a quantity equal to the $\frac{1}{10}$th part of the electromotive force of a Daniell's cell. M. Pellat employs an electrometer to measure the residual difference of potential when the two cells are connected up in opposition to one another, and believes that by this means his observations are free from possible errors due to polarisation when the galvanometer method of comparison is adopted.

HERR EDLUND has drawn attention to an electrical experiment that has not hitherto been thoroughly explained. Let an open metal tube or cylinder, capable of rotation about its axis, be placed over a magnet of double its own length, so that its lower end is opposite the middle of the magnet, while its upper end is opposite the magnet pole. Then let a current of electricity of sufficient strength be passed from one end of the tube to the other. The tube is found to rotate with a velocity which is independent of the resistance of the metal of which it is composed and of its thickness. Longitudinal slits cut in the tube do not affect its rotation. There is therefore here a complete conversion of electromotive force into ponderomotive force. W. Weber inferred that the resistance of the movable conductor to the passage of the current is the medium of this transfer of the energy, and argued that the first tendency is to rotate the current in the conductor, but that as this could not be done without moving electricity through the substance of the conductor, and therefore against its resistance, the principle of least heat requires that the energy should be transferred in an indefinitely short time to the conductor itself, which therefore rotates. Herr Edlund, however, sees in the experiment a confirmation of his "unitary" theory of electricity.

SIGNOR GUIDI, an Italian engineer, has suggested the employment of electricity in the preparation of steel in the following manner:—A dynamo-electric machine driven by steam or water power is caused to electrolyse water; the oxygen and

hydrogen gases thus furnished are to be employed in smelting the carboniferous ore of iron, which is reduced by the hydrogen at the high temperature of the flame, thus producing at one operation either steel or pure malleable iron at will. Signor Guidi states, however, that to turn out two tons daily would require the constant employment of a 120 horse-power engine.

GEOGRAPHICAL NOTES

THE Lisbon correspondent of the *Daily News* telegraphs that Ivens and Capello have arrived ill at Loanda, after two years' exploration. They are suffering from fever and other complaints induced by privation, and were almost without clothes. According to government instructions, they have completed a general map of Loanda. They explored the rivers Quango and Quanza, and the territories bordering on their basins. They could not descend the Quango to its confluence with the Zaire on account of the resistance of the hostile tribes. Capello appears quite old, and hardly recognisable. Ivens is better, though ill. Both are thorough scientific men. They bring important notes extending over 32 degrees, plans of the territories and the roads, and meteorological, magnetic, and geographical observations made with the excellent instruments they carried. They were well received by the chief of the Motiango territory, from which the German explorer, Schultz, was excluded; but the chief would not allow any white man to pass east at the peril of his life. They visited the highlands of Bihé, and explored several rivers to their sources. Nearly all their followers deserted them. They were received with great enthusiasm on their arrival at Loanda, and will go to Mossamedes to recruit, prepare their plans, and write out their observations. The period of their return to Lisbon is uncertain.

AT a late meeting of the Russian Geographical Society some details were communicated as to the expedition exploring North-Western Mongolia under M. Potanin. In a letter the traveller describes his route during July and August, which first led from Tsoosilan to the River Kharkiri, and thence to the Lake of Khirghisnor, layers of coal being found on the way. The banks of that lake being barren, the explorers halted near Lake Baganor, only six versts distant from the other sheet of water. Khirghisnor is a great deal larger than Lake Kharaous, and the Mongols asserted the existence of only two such immense reservoirs in the country—namely, the Oobsa and the Kirghisnor. From the latter the expedition marched south, with intent to strike the point where the waters of Lakes Kharaous and Durganor fall into Dzabchin. On August 4 the travellers came to the salt lake Dzerennor, and not till the 9th did they reach the banks of the River Tachteteli, that being the name applied to the mingled volumes of the large lakes flowing into the Dzabchin. Marching round the southern part of Lake Kharaous, the explorers then arrived at the town of Kobda on September 1, with rich scientific collections of all kinds. M. Potanin intended again making for Oolangol, thence proceeding to Oolookem.

THE committee of the Dutch Arctic Expedition have made known their determination to fit out, for the third time, their little sailing schooner *Willem Barents*. The cost of the new expedition is estimated at a little over 1,000*l*.

AFTER the presidential address and the paper on Sumatra read at the first meeting of the session, the new number of the Geographical Society's periodical gives us some notes on the Cocos or Keeling Islands, from the pen of Mr. H. O. Forbes, who went out to the East in October of last year for the purpose of investigating the fauna and flora of certain districts in the Malay Archipelago. While in Java, before commencing this work, he availed himself of an opportunity of paying a visit to these far-away islands, in order to ascertain what changes had occurred since the visit of H.M.S. *Beagle* in 1836; these are shown on the map accompanying his paper. Next we find a note on the boundary line between Chili and Bolivia, illustrated by a map, which explains to some extent the existing disturbances in South America. The geographical notes furnish an account of the progress being made towards Lake Tanganyika by Dr. Mullen's successors, the late Mr. Frank Oates's researches in Matabeleland, and Major Biddulph's tour in Chitral and Yassin. There is also some information of interest respecting Transcaucasia.

A CONTRACT has been concluded by the Molala Shipbuilding ompany, Sweden, to construct a steamer of Molala Bessemer teel, of 100-horse power, to trade between China and Siberia.

FROM the Abstract Report of the Indian Surveys for 1877-8 we see that a large amount of work was done during the season by the various departments, all now united under one organisation. Some interesting and important details are given of various trans-frontier explorations.

THE October *Bulletin* of the Paris Geographical Society begins with a long and valuable paper by M. Wiener on the Dead City of Gran-Chimu and the city of Cuzco. The paper is accompanied by large and careful plans of the two cities, and we believe is a valuable contribution to a puzzling problem. Admiral Fleuriot de Langle has a paper on African migrations, and M. Jules Girard on the subsidence of the surface of the Low Countries. M. Hamy gives an interesting *compte rendu* of M. G. Retzius's recent work on Finnish Ethnology.

THE ROYAL SOCIETY

THE anniversary meeting of the Royal Society was held on December 1, and a somewhat long address was read by the President Mr. Spottiswoode. After referring to some of the losses by death which the Society had sustained, he passed on to business which has occupied the attention of the Council during the current year.

Two important contributions to the Society's funds are announced. First, an unconditional bequest of 1,000*l*. by the late Mr. Sidney Ellis, of Leicester; and secondly, a legacy by the late Sir Walter Trevelyan, "the interest of which is to be applied to the promotion of scientific research."

The Royal Society, as is well known, possesses a rather extensive gallery of portraits, almost exclusively of Fellows of the Society, but among them also a fine painting of Lord Chancellor Bacon. Many of these portraits, however, have, through the lapse of time, begun to show signs of decay. Acting under the advice of Mr. F. W. Burton, F.S.A., Director of the National Gallery, the Council has entrusted the pictures which seemed most to require attention to the care of Mr. Dyer, of Orchard Street, who is now engaged upon them. Some of the portraits require lining, and others cleaning, or partial restoration. As will be seen from those which have been returned to their places, the work appears to have been done in a satisfactory manner. The present appearance of the pictures has been much improved, and it is hoped that these interesting portraits of those who have gone before us may now be passed on in an unimpaired condition to future generations.

Among other acquisitions 973 portraits of Fellows of the Royal Society, formed by the late J. P. Gassiot, Esq., F.R.S., have been bought during the past year. The collection consists mainly of engravings, many of which are of great artistic merit, and in excellent condition.

During the past year a small but perhaps not unimportant change in the mode of dealing with the papers to be read at the weekly meetings has been made. This consists first, in deciding a week earlier than heretofore, what papers should be advertised for reading: and secondly, in reading each week as many as practicable of those in hand, so as to leave as few as possible to stand over. The weekly journals are now able to announce to the public the papers which will be read at the Royal Society (as has in fact long been the case with other Societies) during the next week. But the main object of this arrangement has been early publication; that is to say, publication both in its technical sense of reading before the Society, and in its more widely accepted sense of appearance in the Society's Proceedings. When this was first proposed, it was feared there would soon arrive a period of scientific famine, and that occasions might occur when the Society would meet with no papers before it. Whether this would be so great a calamity as was at first imagined is still an open question, for such has been the scientific fertility of the season, that the threatened catastrophe has never yet actually occurred.

"But so far from suffering by a deficiency of matter we have more often found our difficulties in the number of papers to be read in a single evening. And on such occasions the Secretaries have been good enough to take especial pains to make themselves masters of the contents of the papers, and to communicate in a few words to the meeting the substance of each. It is, I believe, not too much to say that the 'reading' of papers carried out in this way has been the most agreeable and instructive, and has been particularly provocative of intelligent and pertinent discussion. . . . .

"There is a possible alteration in our arrangements which

has often appeared to me to be worthy of consideration, and which from conversations with some of our Fellows appears to meet with sufficient support to justify my bringing it before this our anniversary. I refer to the hour at which our weekly meetings are held. Hitherto, in accordance with the usage of scientific societies in London, we have met in the evening. But changes in the habits of society, and the increasing distances from Burlington House at which many of our Fellows reside, seem to render a large weekly attendance difficult. On this account it appears to me desirable to inquire whether an afternoon hour might not better suit the convenience of our members. In that case, I should suggest 5.0 P.M.; and as our meetings seldom extend to two hours in duration, it would generally be practicable for Fellows to reach home by about seven o'clock. . . .

"These changes, if adopted, would require the alteration of the Statute relating to the hour of meeting. But if the suggestion were adopted before the end of the year, there would still remain nearly half the Session of our Society after complying with the necessary formalities. . . .

"It has often been suggested," we read, "that our weekly meetings might be rendered more interesting if the communications were more often accompanied by experiments, or by other modes of optical illustration. The Council has hitherto met these requirements by supplying, from time to time, such appliances as appeared necessary. But that important element, the electric light, and batteries on a large scale, have generally been avoided, on account of the inconveniences attending them. It has, however, been thought that authors would be much encouraged to illustrate their communications experimentally if the main appliances were known to be always ready to hand. . . .

"Again, the mode of lighting our meeting-room by means of sunlights has proved inconvenient to many of our Fellows, on account of its heat and glare; and it is considered undesirable to adopt ordinary gas-burners in its stead for fear of injury to the pictures. We are, however, no longer driven to this alternative, as we may now look to the electric light as a possible mode of illumination.

"These considerations have led me to make an offer, as I now do, to the Society, of a gas-engine of eight horse-power, which, in the opinion of those best qualified to judge, will be amply sufficient both for experimental illustration and for illumination. And I have much pleasure in adding that, on hearing of this offer, our Fellow, Mr. Siemens, immediately expressed his wish to add a dynamo-machine, or rather a pair of such machines, of improved construction (one for alternate, the other for direct currents), the principle of which he had already contemplated bringing before the Society. The other requisites, such as an optical lamp and a few instruments of frequent use, will doubtless soon follow. But, in proposing thus to promote experimental illustration of papers read before the Society, I think it right to add that I do not contemplate, nor do I think it desirable, that the Society should in any sense establish a laboratory; all that is here intended is, that the main appliances for illustration should be found ready to hand here, while the special apparatus would be furnished by the authors themselves."

With regard to the government grant and fund, it is in the opinion of the President desirable that the minds, not only of the Council, but also of the Fellows generally should during the present year be turned to the question, whether it is advisable, in the interests of science, that the fund should be maintained: and if so, whether in its present or any altered form?

In May last the Secretary of State for India asked the advice of the Royal Society on the question of deputing to this country Major J. Herschel on the subject of pendulum observations. The subject is one in which the Royal Society has on more than one occasion taken an active interest; and a reply, prepared by Prof. Stokes was sent. Major Herschel is on his way to England, to carry out the proposed work.

The Publications of the Society. — The Catalogue of Scientific Papers.—The second volume of the supplementary decade, viz., 1863–73, has been brought to a close, and copies are now in the hands of the Fellows and the public. It exceeds in bulk any of the earlier volumes of the work, and extends to 1,310 pages. In this supplement, 343 additional scientific serials have been catalogued, making the total of such serials now comprised in the whole no less than 1,938. The donation list for this volume has been the same as that for former volumes, with the addition of a few societies and institutions sanctioned by the Treasury at the recommendation of the Council. The Fellows have the right to purchase the supplement at the same reduced price per volume as the original work. The Council has authorised the preparation of titles for another decade; and some progress has already been made in the work.

An extra volume of the *Philosophical Transactions* (vol. 168) has been issued, in which the observations made by the naturalists who accompanied the Transit of Venus Expeditions to Kerguelen's Land and Rodriguez, and descriptions of their collections by persons specially acquainted with the several subjects are brought together. The volume is divided into four sections, viz., the Botany and Zoology of each of the two islands respectively.

In estimating the affinities of the flora and fauna of Rodriguez, the authors were under great difficulties owing to our imperfect knowledge of the plants and animals of the other Mascarene Islands. But almost all their observations point strongly to the conclusion that the present animals and plants are the remains of a once more extensive flora and fauna which has been gradually broken up by geological and climatic changes, and which more recently has been greatly interfered with by the agency of man.

The papers presented to the Society, and read at the evening meetings, are stated to have been more numerous than in any previous year of its existence, and have during the last twelve months reached a total of 118. Some of them appear to have excited unusual interest among the Fellows and their friends; for, on more than one occasion the meeting-room was filled to an almost unprecedented degree.

The President took the opportunity of expressing his own impressions of a few which fall, more or less, within his own range of study, first of all referring to the assiduity and success with which Mr. Crookes has continued his labours.

The work of the Institution of Telegraph Engineers, the Iron and Steel Institute and other similar associations was then referred to.

The justification for the award of the medals for the present year was thus stated:—

The Copley Metal has been awarded to Rudolph Julius Emmanuel Clausius, Foreign Member of the Royal Society, for his investigations in the Mechanical Theory of Heat.

The mechanical theory of heat as at present understood and taught has been so essentially a matter of growth, that it would be difficult to assign to each investigator the precise part which he has taken in its establishment. It will, however, be admitted by all, that the researches of Clausius rank high among those which have mainly contributed to its development. These researches extend over a period of thirty years, and embrace important applications of the theory not only to the steam-engine, but to the sciences of electricity and magnetism.

Even to enumerate those who have contributed to one branch of the subject, viz., the kinetic theory of gases, would be beyond my present purpose and powers; but as Clausius himself states, both Daniel and John Bernoulli[1] wrote on the subject. And, even, to go back to earlier times, Lucretius[2] threw out the idea; while Gassendi, and our own Boyle, appear to have entertained it. Within our own recollection, Joule, Meyer, Kroning, Clerk Maxwell, and others have made invaluable contributions to this branch, as well as to the general subject of the mechanical theory of heat. But however great the value of these contributions, it may safely be stated that the name of Clausius will always be associated with the development of earlier ideas into a real scientific theory.

A Royal Medal has been awarded to W. H. Perkin, F.R.S. Mr. William Perkin has been, during more than twenty years, one of the most industrious and successful investigators of Organic Chemistry.

Mr. Perkin is the originator of one of the most important branches of chemical industry, that of the manufacture of dyes from coal-tar derivatives.

Forty-three years ago the production of a violet-blue colour by the addition of chloride of lime to oil obtained from coal-tar was first noticed, and this having afterwards been ascertained to be due to the existence of the organic base known as aniline, the production of the coloration was for many years used as a very delicate test for that substance. The violet colour in question, which was soon afterwards also produced by other oxidising agents, appeared, however, to be quite fugitive, and the possibility of fixing and obtaining in a state of purity the aniline product which gave rise to it, appears not to have occurred to

1 In the 10th section of his "Hydrodynamics."
2 "De rerum Naturâ," lib. ii. 111–140.

chemists until Mr. Perkin successfully grappled with the subject in 1856, and produced the beautiful colouring matter known as aniline violet, or mauve, the production of which, on a large scale, by Mr. Perkin, laid the foundation of the coal-tar colour industry.

His more recent researches on anthracene derivatives, especially on artificial alizarine, the colouring matter identical with that obtained from madder, rank among the most important work, and some of them have greatly contributed to the successful manufacture of alizarine in this country, whereby we have been rendered independent of the importation of madder.

Among the very numerous researches of purely scientific interest which Mr. Perkin has published, a series on the hydrides of salicyl and their derivatives, may be specially referred to; but among the most prominent of his admirable investigations are those resulting in the synthesis of coumarin, the odoriferous principle of the tonquin bean and the sweet scented woodruff, and of its homologues.

The artificial production of glycocol and of tartaric acid by Mr. Perkin conjointly with Mr. Duppa, afford other admirable examples of synthetical research, which excited very great interest among chemists at the time of their publication.

It is seldom that an investigator of organic chemistry has extended his researches over so wide a range as is the case with Mr. Perkin, and his work has always commanded the admiration of chemists for its accuracy and completeness, and for the originality of its conception.

A Royal Medal has been awarded to A. C. Ramsay, F.R.S. Prof. Ramsay has been for a period of nearly forty years connected with the Geological Survey of Great Britain, and during by far the greater part of that time either as Director or Director-General of the Survey. During this long period, in addition to his official labours in advancing our knowledge of the geology of this country, he has published works on the "Geology of Arran," "The Geology of North Wales," "The Old Glaciers of North Wales and Switzerland," and "The Physical Geology and Geography of Great Britain," now in its fifth edition. His papers in the *Quarterly Journal* of the Geological Society, and elsewhere, are numerous and important, especially those on theoretical questions in physical geology, such for instance, as "The Glacial Origin of Lake Basins," "The Freshwater Formation of the Older Red Rocks," and "The History of the Valley of the Rhine, and other Valleys of Erosion." There are, indeed, among living geologists few who can claim to have done more to extend our knowledge in the important fields of geology and physical geography.

The Davy Medal has been awarded to P. E. Lecoq de Boisbaudran. The discovery of the metal gallium is remarkable for having filled a gap which had been previously pointed out in the series of known elements. Mendelejeff had already shown that a metal might probably exist, intermediate in its properties between aluminium and indium, before Boisbaudran's laborious spectroscopic and chemical investigation of numerous varieties of blende led him to the discovery and isolation of such a metal.

The separation of the minute traces of gallium compounds from blende is an operation presenting unusual difficulty, owing to the circumstance that compounds of gallium are carried down by various precipitates from solutions which are incapable by themselves of depositing those compounds.

EXPERIMENTAL DETERMINATION OF THE VELOCITY OF LIGHT[1]

II.

FIG. 7 represents a plan of the lower floor of the building. E is a three horse power Lovegrove engine and boiler, resting on a stone foundation; B, a small Roots' blower; G, an automatic regulator. From this the air goes to a delivery pipe up through the floor to the turbine. The engine made about four turns per second, and the blower about fifteen. At this speed the pressure of the air was about half a pound per square inch.

The regulator, Fig. 8, consists of a strong bellows, supporting a weight of 370 pounds, partly counterpoised by 80 pounds, in order to keep the bellows from sagging. When the pressure of the air from the blower exceeds the weight, the bellows commences to rise, and in so doing closes the valve, V.

This arrangement was found in practice to be insufficient, and the following addition was made: a valve was placed at P, and the pipe was tapped a little farther on, and a rubber tube led to a water gauge, Fig. 9. The column of water in the smaller tube is depressed, and when it reaches the horizontal part of the tube, the slightest variation of pressure sends the column from one end to the other. This is checked by an assistant at the valve, so that the column of water is kept at nearly the same point, and the pressure thus rendered very nearly constant. The result was satisfactory, though not in the degree anticipated. It was possible to keep the mirror at a constant speed for three or four seconds at a time, and this was sufficient for an observation. Still it would have been more convenient to have kept it so for a longer time. The test of uniformity was, however, very sensitive, as a change of speed of 0·02 of a revolution per second could be detected.

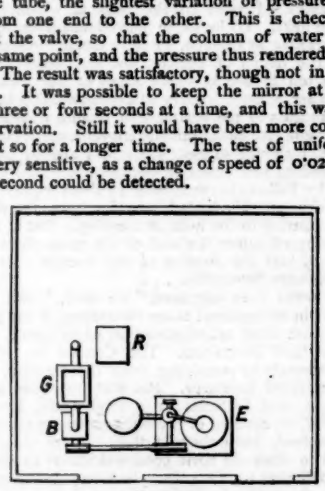


FIG. 7.

It was found that the only time during the day when the atmosphere was sufficiently quiet to get a distinct image was during the hour after sunrise or during the hour before sunset. At other times the image was "boiling," so as not to be recognisable. In one experiment the electric light was used at night, but the image was no more distinct than at sunset, and the light was unsteady.

The method followed in experiment was as follows:—The fire was started half an hour before, and by the time everything was ready the gauge would show 40 or 50 lbs. of steam. The mirror was adjusted by signals as before described. The heliostat was placed and adjusted. The revolving mirror was adjusted by being moved about till the light returned to it from the distant mirror. The axis of the revolving mirror was also inclined to

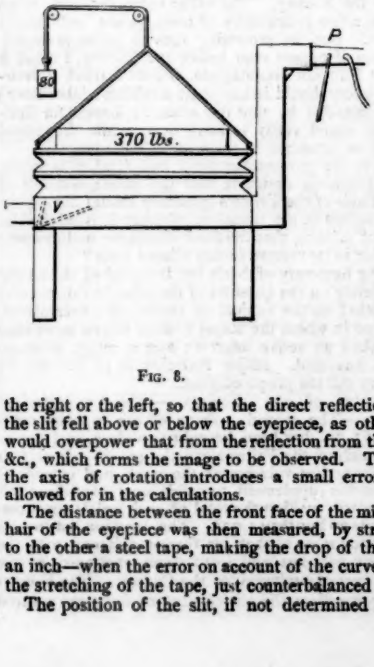


FIG. 8.

FIG. 9.

the right or the left, so that the direct reflection of light from the slit fell above or below the eyepiece, as otherwise this light would overpower that from the reflection from the distant mirror, &c., which forms the image to be observed. This inclination of the axis of rotation introduces a small error, which is duly allowed for in the calculations.

The distance between the front face of the mirror and the cross hair of the eyepiece was then measured, by stretching from one to the other a steel tape, making the drop of the catenary about an inch—when the error on account of the curve, and that due to the stretching of the tape, just counterbalanced each other.

The position of the slit, if not determined before, was then

[1] By Albert A. Michelson, Master, U.S. Navy. Read before the American Association. Continued from p. 96.

found as before described. The electric fork was then started, the temperature noted, and the beats between it and the standard fork counted for 60 seconds. This was repeated two or three times before every set of observations.

The eyepiece of the micrometer was then set approximately, and the revolving mirror started. If the image did not appear, the mirror was inclined forward or backward till it came in sight.

The cord connected with the valve was pulled right or left, till the images of the revolving mirror, represented by the two round spots to the left of the cross hair, came to rest. Then the screw was turned till the cross hair bisected the deflected image of the slit. This was repeated till ten observations were taken, when the mirror was stopped, temperature noted, and beats counted. This was called a set of observations. Usually five such sets were taken morning and evening.

The steel tape used was one of Chesterman's, 100 feet long. It was carefully compared with the copy of the standard yard made by Wurdemann, by a comparator. The result showed that the error of the tape was 0·006 foot. The true length was 100·006 feet.

The micrometer was also compared with the standard yard and the standard meter, the first giving for the value of one scale division, 0·99650 mm.
and the second, 0·99642 ,,

Mean ... ... 0·99646 mm.

One turn of the screw was found equal to 1·0009 divisions. Hence the value of one turn was 0·99655 millimeter.

The distance between the pier for the revolving mirror and the stationary mirror was measured by means of the steel tape. Square lead weights were placed along the line, and measurements taken from one to the other, the tape resting on the ground and stretched by a force of 10 pounds. The measurements, five in all, were all made at about 62° F. The results are :—

	1985·13
	1985·17
	1984·93
	1985·09
	1985·09
Mean	1985·082
Correction for stretch of tape	0·33
,, ,, length ,, ...	0·12
Distance from pier to revolving mirror ...	0·70
Total correction	1·15
	1985·08
True distance	1986·23

The rate of vibration of the standard fork armed with a tip of copper foil was found by allowing it to trace its record on the lampblacked cylinder of a Schultz's chronoscope. The time was given either by a sidereal break-circuit chronometer or by a mean time clock. In the former case the break circuit worked a relay which interrupted the current from three Grove cells. In the latter, the circuit was broken by the pendulum. The spark from the secondary coil of a Ruhmkorff was delivered from a wire near the tip of the fork. The rate of the chronometer, the record of which was kept at the Observatory, was very regular. It was found, from observations of transits of stars during the week, to be + 1·3 seconds per day, which is the same as the recorded rate.

The correction for temperature was found by Prof. Mayer to be + 0·012 v.s. for a diminution of 1° F.

My own result was + 0·0125 v.s.

Adopted + 0·012.

The following is the table of results :—

	256·069
	256·089
	256·077
	256·012
	256·087
	256·074
	256·061
	256·100
	256·084
	256·066
Mean	256·072

In one of these observations I counted the beats between this fork and another, first while the former was tracing its record, and then when it was free and in position as for use. The difference, if any, was less than 0·01 v.s.

As the result obtained depends directly on the rate of vibration of the fork, I was not willing to trust entirely to my own work, and asked Prof. Mayer to make a determination.

He kindly offered to make it together with myself. Accordingly, I went to the Hoboken Institute, and a series of ten determinations were made under the following conditions :—

The fork was wedged into a wooden support, and the tip allowed to rest on lampblacked paper wound about a metal cylinder, which was turned by hand. Break-circuit clock was used, the rate of which was ascertained by comparison with the Western Union time-ball. The spark from the Ruhmkorff passed from the tip of metal attached to the fork, piercing the paper. Size of the spark was regulated by resistances.

Table of results was as follows :—

	256·072
	256·126
	256·091
	256·108
	256·068
	256·090
	256·112
	256·124
	256·080
	256·070
Mean	256·094

The effect of scrape was sought for again, and found to be 0·003 v.s.

The effect of the support, however, was greater, both combined being − 0·026 v.s.

Making this correction, the result becomes :—

	256·068
Former result ...	256·072
Mean	256·070 vibrations per second, at 65° F.

The formulæ employed in the calculations are :—

$$(1) \quad \ldots \quad \ldots \quad \ldots \tan\phi = \frac{d_1}{r}$$

$$(2) \quad \ldots \quad \ldots \quad \ldots \quad V = \frac{2592000'' \times D \times n}{\phi''}$$

Where ϕ = angle of deflection.
d_1 = displacement, or $r \cdot \tan\phi$.
r = radius of measurement.
D = twice the distance between mirrors.
n = number of revolutions per second.
α = inclination of plane of rotation.
V = velocity.

D and r are expressed in feet, and d_1 in millimetres.

Substituting for d_1 its value,

$$d \times 0{\cdot}99655 \times \sec\alpha,$$

where d_1 is the displacement in turns of screw,
and $\log \sec\alpha = 0{\cdot}00008$,
we have, reducing to kilometres :—

$$(3) \quad \ldots \quad \ldots \quad \tan\phi = c_1\frac{d}{r} \qquad \log c_1 = 0{\cdot}51457$$

$$(4) \quad \ldots \quad \ldots \quad \ldots \quad V = c\frac{n}{\phi} \qquad \log c = 0{\cdot}49670$$

In the calculations the effect of temperature on the screw, scale, and tape used in finding ρ was neglected. It can be applied to the final result for the mean temperature, which was 75·6° F.

Correction for $\tan\phi$ is $-0{\cdot}000003 \times 13{\cdot}1 = -0{\cdot}0004$.

Correction for V is + 12 kilometres.

The direction of rotation was right-handed. To eliminate any possible error on this account, the mirror in eight of the later observations was inverted, thus making the rotation left-handed, and the deflection measured to the left. The results were the same as before, within the limits of error.

To eliminate errors due to a regular variation in speed during every revolution, if any such could exist, the position of the frame was changed in several experiments. The results were the same as before.

To test the question as to whether the vortex of air about the mirror had any effect on the deflection, the speed was lowered to 192, 128, 96, and 64 turns per second. If the vortex had any effect, it should have decreased with the lower speed, but no such effect could be detected.

Finally, to test if there were any bias in making the observations, the readings in several sets were taken by another, and the results written down without divulging them. The separate readings, as will be shown in the following specimen, were as consistent as when made by myself, and the final results agree with those of other observations :—

Specimen of Observations

June 17, Sunset. Image good (best in column 4).

	(1)	(2)	(3)	(4)	(5)
	112·81	112·80	112·83	112·74	112·79
	112·81	112·81	112·81	112·76	112·78
	112·79	112·78	112·78	112·74	112·74
	112·80	112·75	112·74	112·76	112·74
	112·79	112·77	112·74	112·76	112·77
	112·82	112·79	112·72	112·78	112·81
	112·76	112·73	112·76	112·78	112·77
	112·83	112·78	112·81	112·79	112·75
	112·78	112·79	112·74	112·83	112·82
	112·82	112·73	112·76	112·78	112·82
Means =	112·801	112·773	192·769	112·772	112·779
Zero =	0·260	0·260	0·260	0·260	0·260
d =	112·541	112·513	112·509	112·512	112·519

Temp. = 77°, B = + 1·500, cor. = − 0·144, diff. = + 1·356, added to 256·070 = 257·426 = n
28·155 = r

Results from the above.

299,660	299,740	299,740	299,740	299,720

Data for Working out Observations

Ut_3 fork makes 256·070 vibr. per sec. at 65° F.
D = 3,972·46 feet.
tan α = tangent of inclination of plane of rotation = 0·02.
c_1 = log = 0·51457.
c = log = 0·49670.
d = deflection as read from micrometer.
r = radius.
ϕ = angle of deflection.
n = number of revolutions per second.
V = velocity of light in kilometres.
B = number of beats per second between electric Ut_3 fork and standard Ut_3 fork. Electric fork makes ½ (256·07 + B + cor.) vibr. per second, and n is a multiple submultiple or simple ratio of this.
Cor. = correction for temperature of standard,
= − 0·012 v.s. per degree F.

Mean result[1]	...	...	299,728
Cor. for temp.	...	...	+12
Vel. of light in air	...	...	299,740
Cor. for vacuum	...	...	+88

Vel. of light *in vacuo* = 299,828 kilometres per second.

[1] In the original a table of observations appears which we are obliged to omit for want of space, while we give the result of the same.

SCIENTIFIC SERIALS

American Journal of Science and Arts, November.—Mr. Stockwell, who has been systematically examining the physical theory of the moon's motion, here calls attention to a secular inequality in that motion, produced by the oblateness of the earth. For attracted points out of the plane of the equator, and not beyond the parallels of 35° 16′ (which is the moon's case), the attraction of the earth is less than it would be if the latter were spherical. The author says he has found several inequalities in the moon's motion, not recognised by existing theories, and of even greater practical importance than the foregoing.—The diamagnetic constants of bismuth and calc-spar in absolute measure have been determined by Prof. Rowland and Mr. Jacques. In their paper the former develops mathematical expressions for the various coefficients of magnetisation, while the latter describes the experimental method adopted: first, exploration of the field, and then noting the time of swing of little suspended bars of the substances in it. The constants for bismuth are

$$\left.\begin{matrix} k_1 = -\ 0{\cdot}000000012554 \\ k_2 = -\ 0{\cdot}000000014324 \end{matrix}\right\};$$

for calc-spar,

$$\left.\begin{matrix} k_1 = -\ 0{\cdot}000000037930 \\ k_2 = -\ 0{\cdot}000000040330 \end{matrix}\right\}.$$

—Mr. Gibbs's elaborate paper on vapour-densities is here concluded. The relation between temperature, pressure, and volume for the vapours of peroxide of nitrogen, formic acid, acetic acid, and perchloride of phosphorus, differs widely from that expressed by the usual laws, and the hypothesis of a compound nature of the vapour is probable. Mr. Gibbs had proposed equations to express the relations between temperature, pressure, or volume, and quantities of the components in such a "gas mixture of convertible components." In his paper he reviews all known experimental determinations of the vapour densities, and finds fair agreement with formula.—We note also accounts of Mr. Michelson's recent experimental determination of the velocity of light; of the remarkable Kane Geyser well (arising from a conflict between gas and water in a petroleum region), and of Mr. Edison's resonant tuning-fork.—Besides Prof. Marsh's recent address, there are further notes by him of new Jurassic mammals from the Rocky Mountains, showing a resemblance to known types of the Purbeck in England.

The American Naturalist, vol. xiii. No. 11, November, contains :—B. B. Redding, How our ancestors in the Stone Age made their implements; Isaac C. Martindale, Colorado plants; C. G. Siewers, Mould as an insect destroyer; W. N. Lockington, Notes on Pacific Coast fishes and fisheries; William Trelease, On the fertilisation of our native species of Clitoria and Centrosema; Recent Literature; General Notes; Scientific News; Proceedings of Scientific Societies.

Annalen der Physik und Chemie, No. 10.—A useful paper by Herr Fromme, in this number, treats of the electromotive force of the Grove, Bunsen, and Daniell batteries, as related to concentration of the liquids. The force of a Grove, whenever this cell is traversed by a very weak current, decreases continuously with concentration of nitric acid and approximately in proportion. That of the Bunsen, under like conditions, is, for the higher concentrations, about equal to that of the Grove, but from a concentration C = 55 greater, because it remains constant, while the decrease in the Grove goes on. The force of the Grove increases with increased concentration of the sulphuric acid to a maximum between C = 25, and C = 35, and thereafter decreases at a more rapid rate.—Herr Kundt and Herr Röntgen have succeeded in proving electromagnetic rotation of the plane of polarisation in several of the less easily condensed gases; and quantitative results for air, hydrogen, oxygen, carbonic oxide, and marsh gas, are here given. The rotation is in direction of the positive current (as with water and sulphide of carbon), and its amount is approximately proportional to the density. It is estimated that 253 km. air in the north-south direction would give a rotation of 1°. The author's apparatus (including a means of compression to about 250 atm.) is described.—Prof. Lommel contributes two papers; in one of them, on Newton's dust rings, he seeks to show the adequacy of the diffraction-theory to explain the phenomena, as against the diffusion theory (interference of diffusely reflected light); in the other paper, on Stokes's law, he controverts M. Lamansky's experimental support of the general validity of this law, which he (Prof. Lommel) had before impugned, as inapplicable to a certain "critical region" in which the fluorescence and absorption-spectra overlap.—Herr Wüllner describes a five-band spectrum of oxygen obtained both from the positive and the negative light in spectral tubes, to which was admitted oxygen produced by electrolysis. When the charge of gas was allowed to stand a quarter to half an hour, the spectrum was changed into that of carbon.—Herr Narr endeavours further to show that the loss of electricity by an insulated body in a gas cannot alone be explained by rise of temperature of the gas, or conduction through the insulating supports, or the presence of particles of foreign substances, as dust, water, or mercury vapour. Nor is there, apparently, a special conductivity of the gas in the ordinary sense.—The changes of density produced in steel by hardening and annealing, are indicated by Herr Fromme.—Herr Riecke has a mathematical paper on the doctrine of the poles of a bar-magnet; and Herr Gerland shows historical reason for believing that the caloric engine was conceived by Leibnitz in 1706, and that Papin is alone the inventor of the centrifugal pump.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, November 27.—"A Memoir on the Single and Double Theta-Functions," by A. Cayley, F.R.S., Sadlerian Professor of Pure Mathematics in the University of Cambridge.

Chemical Society, November 20.—Dr. Gilbert in the chair.—The Chairman announced that a ballot for the election of Fellows would take place at the next meeting, December 4.—The following papers were read:—A chemical study of vegetable albinism, Part II. Respiration and transpiration of albino foliage, by Mr. Church. White foliage does not possess the power even in sunshine of decomposing the carbonic acid in the air. Experiments were made with leaves of the maple, holly, ivy, and Alocasia; 1,000 sq. ctm. of the leaves of the Alocasia evolved in two hours, 15·06 and 38·96 parts of carbonic acid per 10,000; 1,000 sq. ctm. of green leaves 1·14 parts. White holly sprays placed in water, gained in two hours five times as much in weight as green leaves, but when no water was supplied, the green lost about twenty times as much as the white.—Contributions to the history of putrefaction, Part I., by Mr. C. T. Kingzett. The author has examined dilute solutions of albumen, beef, and fish as to their oxygen-absorbing power in different stages of putrefaction, by titrating with permanganate. He finds that such substances require less oxygen as the putrefactive process proceeds; he also discusses the bearing of his results on the permanganate method of estimating the organic matter in potable waters.—Notes on manganese dioxide, by C. R. A. Wright and A. E. Menke. The authors have made an exhaustive study of the various methods for preparing manganese dioxide; in most cases the product contains potash and is deficient in oxygen; the methods which yielded the purest manganese dioxide were, heating manganese nitrate to 160° C., mixing a hot solution of a manganese salt with an excess of permanganate, or in the cold with the addition of zinc sulphate or ferric chloride. The volumetric processes of Kessler and Pattinson gave good results; the authors suggest some convenient modifications of these methods; they have verified the statements of Gorgeu, Guyard, and Pickering, but have disproved those of Morawski and Stingl.—On the reaction between sodium thiosulphate and iodine; estimation of manganese oxides and potassium dichromate, by S. Pickering. The author has carefully worked out the influence of dilution, excess of potassium iodide, heat, and other conditions, on the results obtained by Bunsen's volumetric method of estimating manganese oxide. He suggests a simplified method of procedure and compares results obtained by the two processes.

Linnean Society, November 28.—Prof. Allman, president, in the chair.—Messrs. Winslow, Jones, and Wm. Wickham were elected Fellows.—Sir J. D. Hooker exhibited a specimen and read a paper on the discovery of a variety of the cedar of Lebanon on the mountains of Cyprus (see *Science Notes*).—The president also laid on the table examples of a cone-bearing *Cedrus deodora*, grown by Mrs. C. St. Clair at Parkstone, Dorset.—Mr. E. M. Holmes exhibited and made remarks on a series of rare British lichens, Hepaticæ, and freshwater algæ. He noted that the so-called *Echinella articulata* which now chokes the filter beds of the reservoir at Bradgate, Leicester, was in reality an undescribed form, but bearing resemblances to Zoogloea. Mr. Holmes likewise exhibited, and for the first time in England, the leaves, flowers and portion of the trunk of the tree (*Andira araroba*) yielding the so-called Goa powder. This vegetable secretion appears to destroy and replace the woody tissue of the heart-wood. The source of the powder was long enveloped in mystery, but from its containing chrysophanic acid it was believed to be the product of a fungus. Recently it has been found that the cane grows in Bahia, is sent to Lisbon, thence exported to the Portuguese colonies in the East where it is used as a specific for ringworm.—Mr. T. Christy showed two aboriginal Australian skulls with occipital thickening (forwarded by Dr. Bancroft), and supposed to have been induced by the blows of knobkerries.—Mr. Marshall Ward read a contribution to our knowledge of the embryo sac of phanerograms. In this paper, stages in the development of the ovule in *Butomus umbellatus*, *Alisma plantago*, *Anemone japonica* and other forms have been carefully observed and delineated from microscopic section. The views of Strasburger, Vesque and Warming are severally compared and reviewed, the author holding intermediate opinions. Mr. Ward advances the following:—The ovule so far as its nucleus is concerned arises as a group of cells which divide and become arranged in groups of sister cells symmetrically related to the shape of the whole organ. One cell group leads in growth and fulfilling a special purpose, becomes the embryo sac. Further feeble division of this latter produces a watery cell with two nuclei. Each nucleus again produces four nuclei by bipartite division followed by grouping, and a nucleus from the top group moves towards the middle sap cavity. Each group of four cells is a prothallus, and the cell producing this a macrospore. The two most successful macrospores behave similarly to those of some vascular cryptograms, and finally germinate, producing a ruddy prothallus of four naked nuclei. The egg-cell is an oösphere, all that is left of the lower part of the rudimentary archegonium, its upper part probably being represented by the two "synergidæ" which are to be looked upon as having acquired a secondary function from being merely protective and guiding neck-cells of an archegonium.—Mr. Alfred Haddon read a paper on the extinct land tortoises of Mauritius and Rodriguez. Examination of a large store of material obtained by Mr. Edward Newton, corroborates the two Mauritian species *Testudo triserrata* and *T. inepta* described by Dr. Günther; but it adds no fresh example to that apparently unsatisfactory species *T. leptocnemis*. Of remains from the Island of Rodriguez the species *T. Vosmæri* can alone be distinguished. The free coracoid of *T. inepta* is now for the first time recorded, while that of *T. Vosmæri* is wonderfully irregular in character. Great variation in the ankylosis of the coracoid with the shoulder girdle pertains in this extensive series in the Cambridge Museum.—The secretary read in abstract a communication by Mr. Edward J. Miers, viz.: On a small collection of crustacea made by Mr. Edward Whymper, chiefly in the N. Greenland Seas, with an appendix on additional species collected by the late British Arctic Expedition.

Entomological Society, November 5.—H. W. Bates, F.L.S., F.Z.S., vice-president, in the chair.—Mr. T. R. Billups, of Peckham, was elected an Ordinary Member of the Society.—Mr. W. C. Boyd exhibited a remarkable variety of *Aspilates citraria*, a specimen of *Cidaria testata* in which the hind wings were apparently absent, and a Noctua resembling *Hadena dentina*, but differing from that species in the form of the body. Mr. McLachlan read some remarks he had received from Prof. Forel relative to the sculptured stones on the shores of Lake Leman. Three principal types of markings were described, the first of which was ascribed to the agency of *Tinodes*.—Prof. Westwood exhibited a series of drawings illustrating the economy and transformations of several species of trichopterous and other neuropterous insects, also drawings of some undescribed species of exotic heteropterous-hemiptera contained in the Hopeian collection; he likewise drew attention to a modification of the professorship which had been proposed by the Oxford Commissioners, whereby the science of entomology would probably be neglected, and which would to a certain extent render nugatory the intentions of the founder of the professorship and donor of the collections. Prof. Westwood also referred to the affinity of the genus *Polyctenes*.—Mr. J. Jenner Weir exhibited some ants, apparently a species of *Atta*, which he had found in large quantities at Pisa, and which were peculiar in having collected around their nests, large quantities of small empty shells of *Helix capuata* and *H. virgata*; Mr. Weir also exhibited a specimen of an *Orgyia*, stated on the authority of Mr. Gates to have emerged from the larval skin, without passing through the pupal state.—Mr. W. L. Distant communicated a note relative to some Indian hemiptera which he had received from India through Mr. F. Moore for examination, with the names of the plants on which they were found.—The Secretary read a note and exhibited a photograph which he had received from Dr. Fritz Müller.—The following papers were also communicated:—"List of the Hemiptera collected on the Amazons by Prof. Trail," Pt. I, by Dr. F. Buchanan White.—"Descriptions of new Genera and Species of Tenebrionidæ from Madagascar," by Mr. F. Bates;—and "Descriptions of new Coleoptera from East Africa and Madagascar," by Mr. C. O. Waterhouse.—Mr. Butler communicated a paper on the natural affinities of the lepidoptera hitherto referred to the genus *Acronycta* of authors.—From an examination, chiefly of the larval characters, the author proposed to distribute the British species of the genus among the Arctiidæ, Liparidæ, Notodontidæ, and Noctuites.

Meteorological Society, November 19.—Mr. C. Greaves, F.G.S., president, in the chair.—The following gentlemen were elected Fellows:—Capt. C. K. Brooke, Rev. E. Carr, M.A., Capt. R. A. Edwin, R.N., W. B. Fawcett, C. J. Harland, J. Lucas, F.G.S., H. Mellish, G. B. Nichols, the Earl of Northesk, Dr. J. Robb, T. H. Walker, and C. L. Wragge, F.R.G.S.—The

reports on the phenological observations for 1879 were read, the Botanical being by the Rev. T. A. Preston, M.A., F.M.S., the Entomological by the Rev. C. H. Griffith, B.D., F.M.S., and the Ornithological by J. Cordeaux. With the exception of a few days in the earlier parts of February and of March, the whole of the year 1879 has been characterised by a temperature almost invariably below the mean, accompanied with much wet and little or no sun; the effect on vegetation has been consequently very great. Foliage has, as a rule, been excessively luxuriant and dark, "forming the most remarkable feature of the year;" but rarely has fruit been able to ripen, and the second shoots have frequently been weak and unhealthy. Flowering has invariably been very late, as much as a month in some districts, the hay harvest often not completed till nearly the end of August, some still in "cock" in the Moorland district of Staffordshire, as late as September 30; and the corn harvest not only extremely late, but the corn in very poor condition, not properly ripened. With regard to insects the two most notable occurrences of this most dismal season have been the swarms of *Pyramis cardui* and *Plusia gamma*; both these species have been wonderfully numerous, especially the latter, which has absolutely swarmed. The great severity of the past winter caused an almost unprecedented mortality amongst birds, great numbers of various species succumbing to the cold. This mortality was perhaps most apparent amongst the Turdidæ and the starlings. Spring brought little or no improvement, birds nested much beyond their average time, and in a vast number of instances the first eggs have been addled and destroyed by cold rains and an abnormally low and continuous temperature. The scarcity of young partridges is probably unprecedented, on some manors not a young bird is to be found, and it will take several good nesting seasons to bring up the stock of their old numbers. —A paper on the meteorology of Zanzibar, by Dr. John Robb, was also read. The average annual rainfall is rather more than 61 inches, or only about double the average yearly fall in England; and the average number of rainy days is 120. The greater rains fall in March, April, and May, the lesser rains are from mid-October to the end of the year. The driest month is September, with an average rainfall of 1·86 inch; no month is rainless. The mean temperature of five years is 80°·6, and the average yearly range, from highest maximum to lowest minimum, is 17°·3. The hottest months of the year are February and March, with a mean temperature of 83°·1 and 83°·4 respectively; the cool months are July and August, averaging 77°·5 and 77°·7. This gives a small amplitude of the yearly fluctuation, rather less than 6°, and to this limited range of temperature is largely due the debilitating nature of the climate of Zanzibar, particularly as affecting the nervous system. The heat is constant and moist, and even gentle exercise is usually attended with excessive perspiration.

PARIS

Academy of Sciences, November 24.—M. Daubrée in the chair.—The following papers were read:—On the heat of formation of ammonia, by M. Berthelot. He was led to doubt previous data. The action of chlorine on ammonia cannot rightly be used (as it has been) for the purpose, nor that of hypobromites, though preferable. M. Berthelot resorted to direct combustion of ammoniac gas by means of free oxygen. He arrives at + 21·0 and + 12·2 cal. for the heat of formation of dissolved and gaseous ammonia respectively. Between + 12·2 and + 26·7 (the number previously adopted) there is + 14·5 difference (the largest experimental error hitherto made in thermochemistry).—On crystallised chlorophyll, by M. Trécul. A claim of priority; he described crystals of chlorophyll in 1865.—Geodetic junction of Algeria with Spain; international operation executed under the direction of Gen. Ibañez and M. Perrier, by M. Perrier. Science has now a meridian arc of 27°, the largest that has been measured on the earth and projected astronomically on the sky. M. Perrier gives interesting details of the work, which included transport of steam-engines and Gramme machines, &c., to four mountain tops, Mulahacen and Tetica in Spain, Filhaoussen and M'Sabiha between Oran and the frontier of Morocco. Military guards were required, and the parties watched for signals from August 20 till September 9, without success. The observations, commenced on the latter date, terminated October 19. —Experimental researches on a new property of the nervous system, by M. Brown-Sequard. Certain parts of the nervous system, when under irritation, cause suddenly, or nearly so, a notable increase of the motor or sensitive properties of other parts of the system. Thus transverse section of a lateral half of the base of the brain increases the motor properties of the parts of this centre before the section, while the opposite is produced on the opposite side; the same with section of the sciatic nerve, or a lateral half of the dorsal or lumbar cord.—Researches on nitrification, by MM. Schlœsing and Muntz. They appear to have isolated the organism which effects the oxidation of nitrogen, *the nitric ferment*. The corpuscles are abundant, very small, and slightly elongated. The ferment is killed infallibly by a temperature of 100°, and 90° seems to stop its action. Deprivation of oxygen and desiccation are unfavourable to it. In media rich in organic matters, mucor is its chief enemy. It is not found normally in air; mould is its most favourable medium.—Observations on the egg-laying of winged phylloxeras in Languedoc, by M. Mayet.—On quadratic forms, by M. Poincaré.—Determination of curves and surfaces satisfying the conditions of double contact, by M. Zeuthen.—Specific heat of solutions of hydrochloric acid, by M. Hammerl. He tabulates his results, and modifies M. Marignac's formula so as to make it applicable to concentrated solutions.—On a new mode of separation of nickel, and of cobalt, by M. Dirvell. This consists in mixing with a solution containing cobalt and nickel, a (cold) saturated solution of salt of phosphorus, mixed with a solution of bicarbonate of ammonia, no longer giving any ammoniacal odour.—Constitution of dibromised ethylene, by M. Demole.—New method of analysing with precision the potashes of commerce, by MM. Corenwinder and Contamine. This method (very rapid and exact) relieves the operator of the necessity of first separating the sulphuric acid, phosphoric acid, and silica, which form with soda insoluble combinations in alcohol.—On the alterations of the epidermis, in affections of the skin, or of mucous membranes, which tend to the formation of vesicles, pustules, or pseudo-membranous productions, by M. Leloir.—Observations on the salivary glands of the Echidna, by M. Viallanes. The parotid glands, so constant in mammalia, have in this case escaped the attention of Cuvier and Owen, and the latter denies their existence in Echidna; but the author found them well developed. Instead of being in front of the auditory canal they are far behind it, at the level of the middle of the neck. On either side there are two sub-maxillary glands, one deep, the other superficial, and the latter seems also to have escaped attention.—M. Chasles presented, from Prince Boncompagni, a portion of "Researches on the Manuscripts of Pierre le Fermat followed by unpublished Fragments of Bachet, and of Malebranche."—M. Larrey presented a Portuguese work by M. Ennes, "The Medical Life of Nations."

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